Final Environmental Impact Statement

for the

Generic Essential Fish Habitat Amendment to the following fishery management plans of the Gulf of Mexico (GOM):

SHRIMP FISHERY OF THE GULF OF MEXICO
RED DRUM FISHERY OF THE GULF OF MEXICO
REEF FISH FISHERY OF THE GULF OF MEXICO
STONE CRAB FISHERY OF THE GULF OF MEXICO
CORAL AND CORAL REEF FISHERY OF THE GULF OF MEXICO
SPINY LOBSTER FISHERY OF THE GULF OF MEXICO AND SOUTH ATLANTIC
COASTAL MIGRATORY PELAGIC RESOURCES OF THE GULF OF MEXICO AND SOUTH ATLANTIC

VOLUME 1: TEXT

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COVER SHEET

Environmental Impact Statement for the Generic Essential Fish Habitat Amendment to the fishery management plans of the Gulf of Mexico

	Draft ()	Final (X)
Type of Action:	Administrative (x)	Legislative ( )

Area of Potential Impact: Areas of tidally influenced waters and substrates of the Gulf of Mexico and its estuaries in Texas, Louisiana, Mississippi, Alabama, and Florida extending out to the limit of the U.S. Exclusive Economic Zone (EEZ)

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ABSTRACT

This Environmental Impact Statement (EIS) analyzes within each fishery a range of potential alternatives to: (1) describe and identify Essential Fish Habitat (EFH) for the fishery, (2) identify other actions to encourage the conservation and enhancement such EFH, and (3) identify measures to minimize to the extent practicable the adverse effects of fishing on such EFH. The EIS contains the scientific methodology and data used in the analyses, background information on the physical, biological, human, and administrative environments, and a description of the fishing and non-fishing threats to EFH.

Additional copies of this EIS may be obtained by contacting the Regional Contacts (above) or at the address below.

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ACRONYMS/ABBREVIATIONS

ABC	acceptable biological catch
ADCNR, MRD	Alabama Department of Conservation and Natural Resources, Marine Resources Division
AFS	American Fisheries Society
ALARM	Automated Landings Assessment for Responsive Management
AP	advisory panel
ASAP	Age Structured Assessment Program
ATCA	Atlantic Tuna Convention Act
BRD	bycatch reduction device
CAGEAN	Catch at age analysis
CCA	Coastal Conservation Association
CFD	Coastal Fisheries Division
CMC	Center for Marine Conservation (now Ocean Conservancy)
ComFIN	Commercial Fisheries Information Network
Council	Gulf of Mexico Fishery Management Council
CPUE	catch per unit effort
CZMA	Coastal Zone Management Act
DEIS	draft environmental impact statement
DOC	U. S. Department of Commerce
DOI	Department of Interior
EA	environmental assessment
EEC	European Economic Community
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
E.O.	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
F	instantaneous fishing mortality rate
FACA	Federal Advisory Committee Act
FCZ	fishery conservation zone (is now called EEZ)
FDEP	Florida Department of Environmental Protection
FERC	Federal Energy Regulatory Commission
FFWCC	Florida Fish and Wildlife Conservation Commission
FKNMS	Florida Keys National Marine Sanctuary
FL	fork length
FAO	Food and Agriculture Organization
FMP	fishery management plan
FMRI	Florida Marine Research Institute
FTTS	Florida Trip Ticket System
GAFF	Gulfwide Association of Finfish Fishermen
GIS	Geographical Information System
GLM	general linear model

GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
GSA	General Services Administration
GSAFF	Gulf and South Atlantic Fisheries Foundation
GSMFC	Gulf States Marine Fisheries Commission
HAPC	Habitat Areas of Particular Concern
HMS	Highly Migratory Species
HRP	Habitat Research Plan
HSI	Habitat Suitability Index
HSM	Habitat Suitability Model
ICCAT	International Commission on Conservation of Atlantic Tunas
IFQ	Individual Fishing Quotas
IVR	Inter-active Voice Recognition
IRFA	initial regulatory flexibility analysis
ITQ	individual transferable quota
KWCBA	Key West Charterboatmen's Association
LDWF	Louisiana Department of Wildlife and Fisheries
LOA	length overall
LEAP	Law Enforcement Advisory Panel
M	instantaneous natural mortality rate
MAFAC	Marine Fisheries Advisory Committee
MAFMC	Mid-Atlantic Fishery Management Council
MARFIN	Marine Fisheries Initiative
MCCF	Monroe County Commercial Fishermen, Incorporated
MDMR	Mississippi Department of Marine Resources
MFMT	Maximum Fishing Mortality Threshold
MMA	Marine Managed Area
MMS	Minerals Management Service
MP	million pounds
MPA	Marine Protected Area
MRFSS	Marine Recreational Fishery Statistics Survey
M-S Act	Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act)
MSAP	Mackerel Stock Assessment Panel
MSST	Minimum Stock Size Threshold
MSY	maximum sustainable yield
MYPR	maximum yield per recruit
NESDIS	National Environmental, Satellite, Data and Information Service
NEPA	National Environmental Policy Act
NGDC	National Geophysical Data Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Center
NOS	National Ocean Service
NPDES	National Pollutant Discharge Elimination System
OC	Ocean Conservancy (formerly CMC)

OFF	Organized Fishermen of Florida
OMB	Office of Management and Budget
OY	optimum yield
PDF	Portable Document Format
ppt	parts per thousand (salinity)
RA	Regional Administrator of NMFS
RecFIN	Recreational Fisheries Information Network
RFA	Regulatory Flexibility Act
RIR	regulatory impact review
RSW	running sea water system
SAFMC	South Atlantic Fishery Management Council
SAP	stock assessment panel
SASI	Save America's Seafood Industry
SAV	Submerged Aquatic Vegetation
SBA	Small Business Administration
SCRS	Standing Committee on Research and Statistics
SEAMAP	Southeast Area Monitoring and Assessment Program
SFA	Southeastern Fisheries Association
SEFSC	Southeast Fisheries Science Center of NMFS
SEIS	supplemental environmental impact statement
SEP	Socioeconomic Panel
SERO	Southeast Regional Office (NMFS)
SFA	Sustainable Fisheries Act
SMZ	special management zone
SOFA	Southern Offshore Fishermen's Association
SOPPs	Statement of Organization Practices and Procedures
SPL	saltwater products license (FL)
SPR	spawning potential ratio
SSB/R	spawning stock biomass per recruit
SSC	Scientific and Statistical Committee
TAC	total allowable catch
TED	turtle excluder device
TIP	trip interview program
TL	total length
TNRIS	Texas Natural Resources Information Network
TPWD	Texas Parks and Wildlife Division
TSA	Texas Shrimp Association
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VMS	Vessel Monitoring System
VPA	virtual population analysis
WDC/MGG	World Data Center/Marine Geology and Geophysics
YPR	yield per recruit
Z	instantaneous total mortality rate

GLOSSARY

ALGAE - A collective, or general name, applied to a number of primarily aquatic, photosynthetic groups (taxa) of plants and plant_like protists. They range in size from single cells to large, multicellular forms like the giant kelps. They are the foodbase for almost all marine animals. Important taxa are the dinoflagellates (division Pyrrophyta), diatoms (div., Chrysophyta), green algae (div. Chlorophyta), brown algae (div. Phaeophyta), and red algae (div. Rhodophyta). Cyanobacteria are often called blue-green algae, although blue-green bacteria is a preferable term.

ANTHROPOGENIC - Refers to the effects of human activities.

BATHYMETRIC-A depth measurement. Also refers to a migration from waters of one depth to another.

BENTHIC-Pertaining to the bottom of an ocean, lake, or river. Also refers to sessile and crawling animals which reside in or on the bottom.

BIOGENIC-Features built by or consisting of liviving organisms.

BIOMASS-The total mass of living tissues (wet or dried) of an organism or collection or organisms of a species or trophic level, from a defined area or volume.

CALCAREOUS-Composed of calcium or calcium carbonate.

CONTINENTAL SHELF-The submerged continental land mass, not usually deeper than 200 m. The shelf may extend from a few miles off the coastline to several hundred miles.

CONTINENTAL SLOPE-The steeply sloping seabed that connects the continental shelf and continental rise.

CORAL REEF-Coral communities exist under a variety of water depths, bottom types, water quality, wave energy and currents. Well-developed active coral reefs usually occur in tropical and subtropical waters of low turbidity, low terrestrial runoff, and low levels of suspended sediment. Some of the best developed reefs in Puerto Rico are those which receive the lowest levels of terrigenous inputs (Turgeon *et al.* 2002). The percentage of live coral cover generally increases with distance from shore. Corals may occur scattered in patches attached to hard substrates. Corals in the Caribbean are formed by the major reef-building (hermatypic) coral genera *Acropora*, *Montastrea*, *Porites*, *Diploria*, *Siderastrea* and *Agaricia* (Tetra Tech, 1992).

CRUSTACEA-A large class of over 26,000 species of mostly aquatic arthropods having five pairs of head appendages, including laterally opposed jaw_like mandibles and two pairs of antennae.

DEMERSAL-Refers to swimming animals that live near the bottom of an ocean, river, or lake. Often refers to eggs that are denser than water and sink to the bottom after being laid.

DISTRIBUTION-1) A species distribution is the spatial pattern of its population or populations over its geographic range. See RANGE. (2) A population age distribution is the proportions of individuals in various age classes. (4) Within a population, individuals may be distributed evenly, randomly, or in groups throughout suitable habitat.

ECOSYSTEM ENGINEER-Organisms that build biogenic structure or modify subtrates in or on which they live.

ESCARPMENT-A steep slope in topography, as in a cliff or along the continental slope.

ESTUARY-A semi-enclosed body of water with an open connection to the sea. Typically there is a mixing of sea and fresh water, and the influx of nutrients form both sources results in high productivity.

FOOD WEB (CHAIN)-The feeding relationships of several to many species within a community in a given area during a particular time period. Two broad types are recognized: (1) grazing webs involving producers (e.g., algae), herbivores (e.g., copepods), and various combinations of carnivores and omnivores; and, (2) detritus webs involving scavengers, detritivores, and decomposers that feed on the dead remains or organisms from the grazing webs, as well as on their own dead. A food chain refers to organisms on different trophic levels, while a food web refers to a network of interconnected food chains. See TROPHIC LEVEL.

FRINGING REEFS-Emergent reefs extending directly from shore and often extensions of headlands or points, or separated from the shore by an open lagoon.

HABITAT - The particular type of place where an organism lives within a more extensive area or range. The habitat is characterized by its biological components and/or physical features (e.g., sandy bottom of the littoral zone, or on kept blades within 10 m of the water surface).

HABITAT SUITABILITY INDEX - (HSI) An index of the suitability of one or more habitat characteristics (e.g. depth, substrate) for a species. HSIs are used in habitat suitability models.

HABITAT SUITABILITY MODEL - Habitat suitability modeling (HSM) is a tool for predicting the quality or suitability of habitat for a given species based on known affinities with habitat characteristics, such as depth and substrate type. This information is combined with maps of those same habitat characteristics to produce maps of expected distributions of species and life stages.

HABITAT USE DATABASE – The relational database of habitat preferences and functional relationships between fish species and their habitat created for the EFH analysis.

HERBIVORE-An animal that feeds on plants (phytoplankton, large algae, or higher plants).

INSULAR-Of or pertaining to an island or its characteristics (i.e., isolated).

INTERTIDAL-The ocean of estuarine shore zone exposed between high and low tides.

ISOBATH-A contour mapping line that indicates a specified constant depth.

ISOTHERM-A contour line connecting points of equal mean temperature for a given sampling period.

LAGOON-A shallow pond or channel linked to the ocean, but often separated by a reef or sandbar.

LARVAE-An early developmental stage of an organism that is morphologically different from the juvenile or adult form.

LITTORAL-The shore area between the mean low and high tide levels. Water zones in this area include the littoral pelagic zone and the littoral benthic zone.

LIVE-ROCK-Live-Rock or Live-bottom is a special term used by aquarists and the marine aquarium industry to describe hard substrate colonized by sessile marine invertebrates and plants (Wheaton 1989).

NERITIC-An oceanic zone extending from the mean low tide level to the edge of the continental shelf.

NICHE-The fundamental niche is the full range of abiotic and biotic factors under which a species can live and reproduce. The realized niche is the set of actual conditions under which a species or a population of a species exists, and is largely determined by interactions with other species.

OCEANIC-Living in or produced by the ocean.

PATCH REEFS-Small irregular shaped reefs that rise from the bottom and are separated from other reef sections. Patch reefs are diverse coral communities typified by the presence of hermatypic (reef-building) and ahermatypic species. Typically, patch reefs form on coralline rock or another suitable substrate such as coral rubble (Marszalek, *et al.* 1977).

PELAGIC-Pertaining to the water column, or to organisms that live in the water column.

PISCIVOROUS-Refers to a carnivorous animal that eats fish.

PRECAUTIONARY-The precautionary approach involves the application of prudent foresight. Taking account of the uncertainties in fisheries systems and the need to take action with incomplete knowledge, it requires, *inter alia:* consideration of the needs of future generations and avoidance of changes that are not potentially reversible; prior identification of undesirable outcomes and of measures that will avoid them or correct them promptly; that any necessary corrective measures are initiated without delay, and that they should achieve their purpose promptly, on a timescale not exceeding two or three decades; that where the likely impact of resource use is uncertain, priority should be given to conserving the productive capacity of the resource; that harvesting and processing capacity should be commensurate with estimated sustainable levels of resource, and that increases in capacity should be further contained when resource productivity is highly uncertain; all fishing activities must have prior management authorization and be subject to periodic review; an established legal and institutional framework for fishery management, within which management plans that implement the above points are instituted for each fishery, and appropriate placement of the burden of proof by adhering to the requirements above.

PRODUCTION-Gross primary production is the amount of light energy converted to chemical energy in the form of organic compounds by autotrophs like algae. The amount left after respiration is net primary production and is usually expressed as biomass or calories/unit area/unit time. Net production for herbivores and carnivores is based on the same concept, except that chemical energy from food, not light, is used and partially stored for life processes. Efficiency of energy transfers between trophic levels ranges from 10_65% (depending on the organism and trophic level). Organisms at high trophic levels have only a fraction of the energy available to them that was stored in plant biomass. After respiration loss, net production goes into growth and reproduction, and some is passed to the next trophic level. See FOOD WEB and TROPHIC LEVEL.

RANGE-(1) The geographic range is the entire area where a species is known to occur or to have occurred (historical range). The range of a species may be continuous, or it may have unoccupied gaps between populations (discontinuous distribution). (2) Some populations, or the entire species, may have different seasonal ranges, These may be overlapping, or they may be widely separated with intervening areas that are at most briefly occupied during passage on relatively narrow migration routes. (3) Home range refers to the local area that an individual or group uses for a long period of life.

REEF FISH-Fish species that live on or near coral reef or hard bottom with biogenic structure.

RISK AVERSE-Philosophy or measures intended to minimize likely adverse impacts or proposed activities.

SETTLEMENT-The act of or state of making a permanent residency. Often refers to the period when fish and invertebrate larvae change from a planktonic to a benthic existence.

SOLITARY CORALS-Individual coral colonies found in bottom communities where corals are a minor component of biotic diversity. Although these solitary corals contribute benthic relief and habitat to communities throughout the fishery conservation zone, they apparently comprise a minor percentage of the total coral stocks in the management area.

SPAWN-The release of eggs and sperm during mating. Also, the bearing of offspring by species with internal fertilization.

SPECIES-(1) A fundamental taxonomic group ranking after a genus. (2) A group of organisms recognized as distinct from other groups, whose members can interbreed and produce fertile offspring.

SUBMERGED REEFS-Fringing reefs that have not developed to the surface; they may be predominantly composed of active coral growth or covered with abundant communities of colonial gorgonians, sponges and corals.

TERRITORY-An area occupied and used by an individual, pair, or larger social group, and form which other individuals or groups of the species are excluded, often with the aid of auditory, olfactory, and visual signals, threat displays, and outright combat.

TRAP LINE-A line that connects a series of traps or pots that are set and hauled together.

TROPHIC LEVEL-The feeding level in an ecosystem food chain characterized by organisms that occupy a similar functional position. At the first level are autotrophs or producers (e.g., kelps and diatoms); at the second level are herbivores (e.g., copepods and snails); at the third level and above are carnivores (e.g., salmon and seals). Omnivores feed at the second and third levels. Decomposers and detritivores may feed at all trophic levels.

VELIGER-A ciliated larval stage common in molluscs. This stage forms after the trochophore larva and has some adult features, such as a shell and foot.

WATER COLUMN-The water mass between the surface and the bottom.

EXECUTIVE SUMMARY

Purpose and need

The purpose of this action is to determine whether to amend the Fishery Management Plans (FMPs) of the Gulf of Mexico Fishery Management Council (Council) pursuant to the mandate contained in section 303(a)(7) of the Magnuson-Stevens Fishery Conservation and Management Act (M-S Act). More specifically, the three-part purpose of this action is to analyze within each fishery a range of potential alternatives to: (1) describe and identify Essential Fish Habitat (EFH) for the fishery, (2) identify other actions to encourage the conservation and enhancement of such EFH and (3) identify measures to prevent, mitigate or minimize to the extent practicable the adverse effects of fishing on such EFH. FMPs must describe and identify EFH for the fishery, minimize to the extent practicable adverse effects on that EFH caused by fishing, and identify other actions to encourage the conservation and enhancement of that EFH.

In 1999, a coalition of environmental groups brought suit challenging the NOAA Fisheries' approval of the EFH FMP amendments prepared by the Gulf of Mexico and other Fishery Management Councils. The court found that the EFH amendments were in accordance with the M-S Act, but held that the EAs on the amendments were in violation of the National Environmental Policy Act (NEPA). NOAA Fisheries entered into a Joint Stipulation with the plaintiff environmental organizations that called for each affected Council to complete an Environmental Impact Statement (EIS).

This analysis was developed and alternatives presented with full anticipation of, and opportunity for, public participation in the development of alternatives. The Council held scoping meetings throughout the Gulf of Mexico in June 2001.

Analytical methodologies used in the EIS

The data analysis undertaken in the development of this EIS for the seven Fishery Management Plans includes spatial analysis of the distribution of habitat types, fish species and fishing effort, development of a database containing information on the habitat associations of managed fish species, and characterization of the sensitivity of specific habitats to impacts by specific fishing gears. The methods and concepts for developing and analyzing the alternatives to be considered are common to all of the FMPs. The methodologies used in this EIS are described in Section 2.1 under four main headings:

- Describing and identifying EFH;
- Identifying HAPCs;
- Addressing adverse effects of fishing on EFH; and
- Evaluating the consequences of the alternatives

Range of Alternatives

EFH Alternatives

Concept 1: No action

Concept 2: Status quo

Concept 4: Known distributions of species in the FMUs

Concept 5: Areas of higher species density, based on the NOAA Atlas only

Concept 6: Areas of higher species density, based on the NOAA Atlas and functional relationships analysis

These concepts are applied to each of the seven FMPs, resulting in 35 alternatives in all.

HAPC Alternatives

Alternative 1. (No Action – roll back) Do not establish any habitat areas of particular concern (HAPCs) under the EFH Amendment.

Alternative 2. (Status quo) HAPC are those general habitat types and specific sites that are listed in the 1998 Generic EFH Amendment; no additional HAPCs are identified.

Alternative 3. HAPCs would consist of selected existing Federally-managed marine areas including 2 National Marine Sanctuaries, 4 National Estuarine Research Reserves, 31 National Wildlife Refuges, 7 National Marine Fisheries Service Critical Habitat Areas Fisheries Management Zones, and 3 National Park Systems.

Alternative 4. Establish major modifications to fishing gears and gear closures on sensitive habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ

Alternative 8. HAPCs are identified as habitat parcels that meet one or more of the considerations set out in the EFH Final Rule (50 CFR, Part 600).

Alternative 9. The following areas are identified as HAPCs: the Flower Garden Banks, Florida Middle Grounds, Tortugas North and South Ecological Reserves, Madison-Swanson Marine Reserve, Pulley Ridge and the following reefs and banks of the Northwestern Gulf of Mexico: Stetson, McNeil, Bright Rezak, Geyer, Mcgrail Bouma, Sonnier, Alderice and Jakkula.

Preventing, mitigating, or minimizing adverse effects of fishing on EFH Alternative

Alternative1. (No Action, status quo). Use existing regulations to prevent, mitigate, or minimize adverse fishing impacts in State and Federal waters of the Gulf of Mexico.

Alternative 2. Establish minor modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

1. No bottom trawling over coral reef
2. Require aluminum doors on trawls
3. Limit bottom longline sets to 6 miles in length, limited to 3 sets/day on hard bottom
4. Require circle hooks on all vertical lines and allow maximum sinker weights of 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs, or handlines
5. Require use of buoys on all anchors

Alternative 3. Establish moderate modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ.
In addition to the restrictions listed in Alternative 2, apply the following action items:

1. Limit use of tickler chains to one chain with a maximum ¼ inch link diameter
2. Limit total trawl headrope length to 180 feet or less
3. Limit trawl vessels to 85 feet or less LOA, and grandfather existing vessels
4. Prohibit trotlines when using traps/pots.

Alternative 4. Establish major modifications to fishing gears and gear closures on sensitive habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ
In addition to the restrictions listed in Alternative 3, apply the following action items:

1. Limit total trawl headrope length to 120 feet or less
2. Limit trawl vessels to 81 feet or less LOA on hard bottom or SAV
3. Prohibit use of tickler chains on hard bottom, SAV, sand/shell, and soft sediments
4. Prohibit use of all traps/pots and bottom longlines and buoy gear on coral reef
5. Prohibit all use of anchors on coral, and require use of mooring buoys if vessels need to "anchor" or maintain a stationary position.

Alternative 5. Prohibit gears and fishing activities that have adverse impacts on EFH from the EEZ.
Apply the following action items:

1. Prohibit use of all bottom trawling gear
2. Prohibit use of all traps and pots
3. Prohibit use of all bottom longline & buoy gear
4. Prohibit use of all spears and powerheads
5. Prohibit use of all vertical gear
6. Prohibit use of all anchors

Alternative 6. Establish minor modifications to fishing gears and a gear closures on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

1. Regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs
2. Prohibit bottom anchoring over coral reefs in HAPCs
3. Prohibit use of bottom longlines, buoy gear, and all traps/pots on coral reefs
4. Prohibit the use of trawling gear on coral reefs
5. Require a weak link in the tickler chain of bottom trawls on all habitats

Alternative 7. Establish some minor modifications to fishing gears and one major gear closure on sensitive live hard bottom habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ.
Apply the following action items on live hard bottom:

1. Limit bottom longline sets to 5 miles in length, and to 3 sets/day
2. Prohibit trotlines when using traps/pots
3. Prohibit all anchoring
4. Enact a seasonal closure for shrimp trawl fishing

Preferred alternatives

<u>EFH Alternatives</u>.

Red Drum FMP – Alternative 6. EFH for the Red Drum FMP consists of all Gulf of Mexico estuaries; waters and substrates extending from Vermilion Bay, Louisiana to the eastern edge of Mobile Bay, Alabama out to depths of 25 fathoms; waters and substrates extending from Crystal River, Florida to Naples, Florida between depths of 5 and 10 fathoms; waters and substrates extending from Cape Sable, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council between depths of 5 and 10 fathoms (Figure 2.3.1).

Reef Fish FMP – Alternative 6. EFH for the Reef Fish FMP consists of Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100 fathoms (Figure 2.3.2).

Coastal Migratory Pelagics FMP – Alternative 6. EFH for the Coastal Migratory Pelagics FMP consists of Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100 fathoms (Figure 2.3.3).

Shrimp FMP – Alternative 6. EFH for the Shrimp FMP consists of Gulf of Mexico waters and substrates extending from the US/Mexico border to Fort Walton Beach, Florida from estuarine waters out to depths of 100 fathoms; waters and substrates extending from Grand Isle, Louisiana to Pensacola Bay, Florida between depths of 100 and 325 fathoms; waters and substrates extending from Pensacola Bay, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 35 fathoms, with the exception of waters extending from Crystal River, Florida to Naples, Florida between depths of 10 and 25 fathoms and in Florida Bay between depths of 5 and 10 fathoms (Figure 2.3.4).

Stone Crab FMP – Alternative 6. EFH for the Stone Crab FMP consists of Gulf of Mexico waters and substrates extending from the US/Mexico border to Sanibel, Florida from estuarine waters out to depths of 10 fathoms; waters and substrates extending from Sanibel, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 15 fathoms (Figure 2.3.5).

Spiny Lobster FMP – Alternative 6. EFH for the Spiny Lobster FMP consists of Gulf of Mexico waters and substrates extending from Tarpon Springs, Florida to Naples, Florida between depths of 5 and 10 fathoms; waters and substrates extending from Cape Sable, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 15 fathoms (Figure 2.3.6).

Coral FMP – Alternative 4. EFH for the Coral FMP consists of the total distribution of coral species and life stages throughout the Gulf of Mexico including the East and West Flower Garden Banks, Florida Middle Grounds, southwest tip of the Florida reef tract, and predominant patchy hard bottom offshore of Florida from approximately Crystal River south to the Keys, and scattered along the pinnacles and banks from Texas to Mississippi, at the shelf edge (Figure 2.3.7).

HAPC Alternatives

Alternative 9. The following areas are identified as HAPCs: the Flower Garden Banks, Florida Middle Grounds, Tortugas North and South Ecological Reserves, Madison-Swanson Marine Reserve, Pulley Ridge and the following reefs and banks of the Northwestern Gulf of Mexico: Stetson, McNeil, Bright Rezak, Geyer, Mcgrail Bouma, Sonnier, Alderice and Jakkula.

Preventing, mitigating, or minimizing adverse effects of fishing on EFH alternatives

Alternative 6. Establish minor modifications to fishing gears and a gear closures on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

1. Regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs
2. Prohibit bottom anchoring over coral reefs in HAPCs
3. Prohibit use of bottom longlines, buoy gear, and all traps/pots on coral reefs
4. Prohibit the use of trawling gear on coral reefs
5. Require a weak link in the tickler chain of bottom trawls on all habitats

1 INTRODUCTION

1.1 Purpose and Need for Action

The purpose of this action is to determine whether to amend the Fishery Management Plans (FMPs) of the Gulf of Mexico Fishery Management Council pursuant to the mandate contained in section 303(a)(7) of the Magnuson-Stevens Fishery Conservation and Management Act (M-S Act). More specifically, the three-part purpose of this action is to analyze within each fishery a range of potential alternatives to: (1) describe and identify Essential Fish Habitat (EFH) for the fishery; (2) identify other actions to encourage the conservation and enhancement of such EFH; and (3) identify measures to minimize to the extent practicable the adverse effects of fishing on such EFH. Depending on the preferred alternatives identified in this Environmental Impact Statement (EIS) the following FMPs could be amended: Red Drum, Reef Fish, Coastal Migratory Pelagics, Shrimp, Stone Crab, Spiny Lobster, and Coral**.** The analysis contained in this document is based upon the best scientific information available and the guidelines articulated in the Final Rule to implement the EFH provisions of the M-S Act (*See* 50 CFR Part 600, Subpart J).

1.2 Need for Action

In the M-S Act, Congress recognized that one of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. To ensure habitat considerations receive increased attention for the conservation and management of fishery resources, the amended M-S Act included new EFH requirements, and as such, each existing, and any new, FMPs must describe and identify EFH for the fishery, minimize to the extent practicable adverse effects on that EFH caused by fishing, and identify other actions to encourage the conservation and enhancement of that EFH.

In 1999, a coalition of several environmental groups brought suit challenging the agency's approval of the EFH FMP amendments prepared by the Gulf of Mexico, Caribbean, New England, North Pacific, and Pacific Fishery Management Councils (*American Oceans Campaign et al. v. Daley et al.*, Civil Action No. 99-982(GK)(D.D.C. September 14, 2000)). The court found that the agency's decisions on the EFH amendments were in accordance with the M-S Act, but held that the Environmental Assessments (EA) on the amendments were in violation of the National Environmental Policy Act (NEPA) and ordered National Marine Fisheries Service (NOAA Fisheries) to complete new, more thorough NEPA analyses for each EFH amendment in question.

Consequently, NOAA Fisheries entered into a Joint Stipulation with the plaintiff environmental organizations that called for each affected Council to complete EISs rather than EAs for the action of minimizing adverse effects of fishing to the extent practicable on EFH. *See AOC v. Evans/Daley et al.*, Civil No. 99-982 (GK)(D.D.C. December 5, 2001). However, because the court did not limit its criticism of the EAs to only efforts to minimize adverse fishing effects on EFH, it was decided that the scope of these EISs should address all required EFH components as described in section 303 (a)(7) of the M-S Act. Further, as the court invalidated the original EAs, it was also determined that the contents of that analysis should not pre-determine any conclusions in the following EIS. The following EIS therefore analyzes alternatives for the EFH FMP amendments, including the alternative that was adopted by the Council and partially approved by NOAA Fisheries in 1999 and other alternatives.

1.3 The NEPA Analysis and Fishery Management Plan Actions

NEPA provides a mechanism for identifying and evaluating the full spectrum of environmental issues associated with Federal actions, and for considering a reasonable range of alternatives to avoid or minimize adverse environmental impacts. NOAA Fisheries and the Gulf Council will consider any new information and alternatives discussed in the EIS to determine whether changes to the EFH provisions of the fishery management plans previously approved by NOAA Fisheries are warranted. As noted in the court's decision in AOC v. Daley, the alternatives NOAA Fisheries must consider under NEPA are not restricted to the options originally presented in the fishery management plan amendments submitted by the Council. The following EIS, therefore, considers "Status quo" and "No action" alternatives separately. The "No action" alternatives describe a scenario in which no action would be taken to comply with the EFH provisions of the M-S Act. The "Status quo" alternatives constitute the current state of the management regime regarding EFH. By including the "No action" alternative in the following EIS, EFH management regimes currently in place would not necessarily drive the outcomes of this analysis. It should be noted that since the Council did not adopt any new measures in the 1998 Generic EFH amendment for minimizing adverse effects of fishing on EFH to the extent practicable, the "No action" and "Status quo" conditions are the same for that specific action in this EIS.

1.4 Public and Agency Participation

1.4.1 Public Participation

This analysis was developed and alternatives presented with full anticipation of, and opportunity for, public participation in the development of alternatives for identifying EFH, identifying HAPC, and measures to prevent, mitigate or minimize adverse effects on EFH from fishing.

Scoping meetings were held from June 14, 2001 to June 28, 2001 in Corpus Christi and Houston, TX; Kenner, LA; Biloxi, MS; and Panama City, Key West, and Tampa, FL to obtain public comments on essential fish habitat issues to be discussed in and potentially added to an Environmental Impact Statement for the Generic Amendment for Addressing Essential Fish Habitat (EFH) for each of the Fishery Management Plans of the Gulf Council. The Gulf Council announced its interest in public views on what alternatives should be considered in the designation of EFH, identification of Habitat Areas of Particular Concern (HAPC), and measures to minimize the impacts of fishing activities and gear to any areas identified as EFH or HAPC.

In February 2002, the Gulf Council announced its intent to hire a contractor to complete an environmental impact statement (EIS) for the Gulf Council's Generic Amendment addressing Essential Fish Habitat (EFH). In April 2002, the council announced that it contracted with MRAG Americas, Inc. to prepare a Draft Environmental Impact Statement (PEIS) for the Gulf Council's Generic Amendment for Essential Fish Habitat (EFH) in the Gulf of Mexico. As part of this effort, the Council notified stakeholders through news releases, its website, and the Federal Register, of the importance of stakeholder involvement, and convened two workshops that occurred April 16 and 17, 2002 in Silver Spring, Maryland and New Orleans, Louisiana.

At a regular council meeting in Destin, Florida, May 15-16, 2002, the Habitat Committee of the Gulf Council received a briefing on development of the EIS and discussed an options paper for developing alternatives. Both the committee meeting and discussion of the committee session at the full council were open to the public.

Also in June and October 2002 and May 2003, the Gulf Council convened its Technical Review Panel and User Review Panel to review the Preliminary and Review Drafts of the Environmental Impact Statement (EIS) for the Generic Essential Fish Habitat (EFH) Amendment in separate meetings in Tampa, Florida. The User Review Panel is comprised of representatives from the recreational, charter, commercial, environmental, oil and gas industry, and wetlands property owner sectors, and provided the Gulf Council and contractor with suggestions and comments of the responsiveness of the documents to issues of concern to their respective user groups. Additionally, at the October 2002 meeting, the Joint Habitat Advisory Panel and the Science and Statistical Committee were also convened to review and discuss the Review Draft EIS for EFH. Each provided comments to the contractor and Council staff.

In June 2002, the council announced the establishment of a website providing an overview of the EIS. A link between the Gulf Council website and the EIS website enabled users to access the website.

The public had further opportunity to participate in the development of the EIS through discussion at the Gulf Council's regular meetings in July, September, and November 2002, and January, March, May, and July 2003. Additionally, the Council held a special two day meeting in June 2003 to review the entire EIS, chose preferred alternatives, and direct the final changes for the Draft EIS that was due for public review beginning in August 2003.

Notifications of the Gulf Council's technical group, advisory panel, committee and regular meetings were all published in the Federal Register, in the Gulf Council newsletter, and on the Council's web page. All of these meetings provided additional opportunity for public comment and recommendations as members of the public were offered an opportunity to present comments to the Committee at several times during each meeting.

The Draft EIS was completed in August 2003 and notice of availability was published in the Federal Register on Friday, August 29, 2003 (68 FR 52018). The Public Comment period was initially scheduled to end November 26, 2003 but was extended until December 1, 2003. During the 90 day public comment period, twelve letters were received at NOAA Fisheries. Comment letters were received from one individual, four regional and national environmental organizations (in one letter), one fishing organization, two corporations, two state agencies, and four federal agency offices. An overview of the public review of the Draft EIS is presented in Chapter 5 and all comments received and responses to comments are presented in Appendix. J.

The Council reviewed all the comments received at its January 2004 meeting, and determined appropriate responses and revisions that should be made to the Draft EIS to prepare it as a Final EIS. This Final EIS was reviewed and approved by the Council at its March 2004 meeting.

1.4.2 Agencies consulted

The Council on Environmental Quality Regulations for implementing the procedural provisions of NEPA emphasized agency cooperation early in the NEPA process. Section 1501.6 states: "Upon request of the lead agency, any other Federal agency which has jurisdiction by law shall be a cooperating agency." In addition, any other Federal agency which has special expertise with respect to any environmental issue, which should be addressed in the statement, may be a cooperating agency" (40 CFR 1501.6). NMFS made no formal requests to United States Department of the Interior Fish and Wildlife Service (USFWS), United States Department of Interior Minerals Management Service (MMS) or United States Coast Guard (USCG) to be cooperating agencies in preparing this EIS. USFWS agreed voluntarily to participate in the development of this EIS and provided data, staff, and review for this analysis. In addition, the Council staff provided technical support. MRAG Americas, Inc. was the contractor.

Along with staff preparers from NMFS, Council staff, and consulting agencies' staff, those who have made contributions to this analysis are listed in section 6.0, List of Preparers.

1.4.2.1 Federal

Both the U.S. Department of the Interior's Fish and Wildlife Service (USFWS) and the U.S. Coast Guard (USCG) have non-voting seats on the Council. USFWS has trust authority for seabird and other avian species in the management areas. Expert USFWS staff serves on the Council Habitat Committee and provided assistance with this analysis. The USCG has expertise with enforcement, search and rescue, vessel accidents and incidents at sea, and human safety at sea. Expert USCG staff provided assistance with this analysis. The Environmental Protection Agency (EPA) is a reviewing agency for all EISs.

1.4.2.2 State

Representatives from the states of Alabama, Florida, Louisiana, Mississippi and Texas have voting seats on the Gulf Council. Expert staff provided assistance with this analysis, as did staff from the Gulf States Marine Fisheries Commission.

1.4.2.3 Contractor

MRAG Americas, Inc., a consulting group with extensive experience in U.S. and international fisheries science and management, and marine resource management systems in general, was contracted by the Gulf Council to produce this EIS. To meet the diverse demands of this project, MRAG Americas brought together a multidisciplinary team of service providers, each one specializing in one or more of the scientific and technical fields required to assess the potential biological, socio-economic, and cumulative impacts of potential alternatives for the designation of EFH and HAPC for managed Gulf fisheries, and to minimize adverse impacts of those fisheries on EFH.

The team included PBS&J, a multi-disciplined environmental and engineering consulting firm; GIS Solutions, Inc., providing GIS application and mapping services; Texas A&M University-Center for Coastal Studies (Corpus Christi), a marine and ecosystem research center; and four individual consultants with specialties in social and economic analyses, non-fishing impacts, and legal expertise in compliance with NEPA. All individual staff members who made contributions to this analysis are listed in section 6.0, List of Preparers.

1.5 Chapter Preview

Based in part on the issues identified during scoping, the EIS discusses a reasonable range of alternatives for identifying and describing EFH and designating HAPCs. The alternatives include several methods of identifying EFH that would result in different areas being designated as EFH. The EIS evaluates the environmental consequences of the EFH designation that would result from each alternative. The EIS also includes an evaluation of the effects of fishing on EFH and an analysis of alternatives to minimize to the extent practicable the adverse effects on EFH from fishing. Similarly, several alternatives for identifying and designating areas within EFH as HAPCs are described along with the environmental consequences of each of the alternatives.

The analysis considers the no-action and preferred alternative, along with a range of other reasonable alternatives. Information from the 1998 EA and the generic amendment is reflected in this analysis. However, additional information and the selection of alternatives come from a review of the best scientific information available, including new information made available since the FMP amendments were originally completed.

Chapter 2 of the EIS provides the methodology for obtaining and analyzing information used in the EIS, and describes and contrasts alternatives, including the preferred alternative, for describing and identifying EFH and HAPCs, and for minimizing the adverse effects of fishing on EFH. The chapter discusses significant issues associated with each alternative, including those identified during scoping, and provides a broad summary and comparison of each alternative. For each alternative, the EIS presents and discusses the geographic range and habitat types included as EFH and HAPC, and each alternative is presented graphically in maps generated by a geographical information system (GIS) designed for this specific purpose. The discussion of each alternative for minimizing the adverse effects of fishing on EFH describes the associated fishery management measures. Chapter 2 concludes with a discussion and explanation of alternatives that were considered but not carried forward for further analysis.

Chapter 3 of the EIS describes the environment affected by the alternative courses of action. This includes a discussion of the areas and habitat types that would be described as EFH and HAPC for each alternative, and resources that may be affected by the alternatives including: the physical and biological resources of the Gulf of Mexico ecosystem, all habitat types, fishery resources and how NOAA Fisheries and the Council manage the fisheries under the seven FMPs (Table 1.5.1), threatened and endangered species and marine mammals, and any other relevant biological resources. With respect to fishery resources, the status of stocks of known species in the fishery management units (FMU) of the FMPs are provided, as well as a description of their habitat and prey preferences by life stage, where this is known.

Additionally, Chapter 3 characterizes the socioeconomic environment by describing the geographic extent and economic factors related to the various fisheries operating in the Gulf of Mexico. This includes the number of vessels and gear types used, a description of fishing communities, how many people are employed in fisheries, and their overall economic impacts. Chapter 3 also contains an analysis of the effects of fishing on fish habitat and threats or impacts from non-fishing activities. An analysis of published and unpublished literature on the effects of fishing on fish habitat includes a more focused analysis of region or fishery specific impacts.

Chapter 4 details the environmental consequences of each alternative for designating EFH and HAPC and minimizing the adverse effects of fishing on EFH. The chapter contains an analysis of the direct and indirect environmental and socioeconomic effects of each alternative. For each alternative for designating EFH and HAPC, the chapter describes the specific environmental consequences in relation to effects on the fishery and other fisheries, protected resources, and non-fishing activities. For each alternative for minimizing adverse effects of fishing on EFH, the chapter evaluates the environmental consequences in relation to effects on EFH, the fishery, other fisheries, and protected resources. The discussion of potential impacts resulting from each alternative is presented in comparative form that clearly distinguishes the environmental consequences of each alternative. The discussion in Chapter 4 includes a description of the conservation benefits and the adverse impacts of the alternatives.

Chapter 5 lists all participants in the public review process of the EIS that took place from 2002 through 2003, and all parties that received the Draft EIS for review. A description of the public review process and how comments were addressed or incorporated into the Final EIS is presented in Appendix J.

The final chapters of the EIS include a list of the preparers (Chapter 6); complete list of references (Chapter 7); all tables (Chapter 8); and all figures (Chapter 9). The Appendices include:

Appendix A – History of Fishery Management in the Gulf of Mexico for Each Fishery Management Plan
Appendix B – Gulf of Mexico Fishery Management Council Habitat Policy and Procedures
Appendix C – Information on Species Distribution and Habitat Associations

Appendix D – Descriptions of Fishing Communities
Appendix E – Community Census Demographic Tables
Appendix F – County Census Demographic Tables
Appendix G – Fishing Permits by Permit Type and Homeport City
Appendix H – Tables of Non-Fishing Impacts by Gulf of Mexico Statistical Zone
Appendix I – Description of Maps and GIS Data Included in the EI
Appendix J – Public Comment and Responses to the Draft EIS

2 ESSENTIAL FISH HABITAT ALTERNATIVES

This section of the EIS includes a detailed description of the methodologies used to obtain and analyze data and other information necessary for developing alternatives and considering their consequences (2.1), the preferred alternatives (2.2), and separate sections to present the range of reasonable alternatives to address each of the three areas relevant to EFH. Section 2.3 provides alternatives for describing and identifying EFH, Section 2.4 provides alternatives for identifying HAPCs as a subset of EFH, and Section 2.5 addresses a range of alternatives for preventing, mitigating, or minimizing adverse effects of fishing and fishing gear on EFH, to the extent practicable. The assessment of these alternatives (Section 4) identifies and considers all the potential consequences that these alternatives have on the various affected environments (Section 3), and includes impacts on the "human environment."

All the alternatives developed take into account all species managed in the seven FMPs (as amended) of the Gulf Council FMPs. Combined, they contain 55 species (excluding coral) in the management units (Table 1.5.1.); 43 within the Reef Fish FMP, four within the Shrimp FMP, three within Coastal Migratory FMP, one within the Red Drum FMP, two within the Stone Crab FMP, and two within the Spiny Lobster FMP. The Coral FMP does not list individual species comprising the management unit, but states that the FMP manages all species of the class Hydrozoa (stinging and hydrocorals) and the class Anthozoa (sea fans, sea whips, precious corals, sea pens, and stony corals). Seven species of coral of the class Hydrozoa and 311 species of the class Anthozoa are referred to specifically in the FMP as occurring in Gulf of Mexico and/or South Atlantic waters.

Councils and NOAA Fisheries have direct management authority over fishing activities and the ability to implement regulations to reduce the adverse effects of fishing on EFH in Federal waters, but not over fishing activities outside Federal waters, and this is reflected in the Alternatives presented in Section 2.5.

Although the Council and NOAA Fisheries do not have any direct management authority for non-fishing activities, under the M-S Act, the designation of EFH (which may extend outside Federal waters) permits the Council and NOAA Fisheries to intervene on Federal activities outside their authority that may affect EFH. Within 30 days of receiving EFH Conservation Recommendations from NOAA Fisheries or the Council, the responsible Federal agency must respond *in writing* to NOAA Fisheries and Councils with the rationale for taking any actions that would be contrary to the recommendations for protecting or conserving EFH. The total area identified and described as EFH provides the boundaries of where this consultation process is applied. State, local, and non-Federal entities are not required to consult with NOAA Fisheries and the Council regarding the effects of actions on EFH, if those activities do not require Federal licenses, permits, or funding.

2.1 Methodologies

This section describes the methodologies used in this EIS to develop the alternatives and analyze the consequences of the alternatives.

2.1.1 Introduction

The EFH Final Rule (50CFR Part 600) provides regulations and guidance on the implementation of the EFH provisions of the M-S Act. It includes information on the types of information that can be used for describing and identifying EFH, designating HAPCs and mitigating fishing impacts on EFH. The guidelines advocate using information in a risk-averse fashion to ensure adequate protection of habitat for all species in the management units.

The data analysis undertaken in the development of this EIS includes spatial analysis of the distribution of habitat types, fish species and fishing effort, development of a database containing information on the habitat associations of managed fish species, and characterization of the sensitivity of specific habitats to impacts by specific fishing gears. This EIS covers the seven fishery management plans in the Gulf of Mexico region, and the implementation of the preferred alternatives occur through these fishery management plans. However, the methods and concepts for developing and analyzing the alternatives to be considered are common to all of the FMPs. The methodologies used in this EIS are described in detail below under four main headings:

- Describing and identifying EFH;
- Identifying HAPCs;
- Addressing adverse effects of fishing on EFH; and
- Evaluating the consequences of the alternatives

The results arising from the application of these methods are presented in the latter parts of this chapter (the alternatives), Chapter 3 (affected environment) and Chapter 4 (consequences) of the EIS.

The following section describes the Federal requirements affecting the scope of the analysis, which help to put the methodologies used into context.

2.1.2 Federal requirements affecting the scope of the analysis

Various Federal laws and regulations set out requirements for data quality and analysis that are applicable to an EFH EIS. Key among them is: the M-S Act (and the EFH Final Rule which implements the requirements of the M-S Act) and the CEQ NEPA regulations.

2.1.2.1 Compliance with the M-S Act

The M-S Act requires that FMPs describe and identify EFH (Section 2.3), and requires that management measures be based on the best scientific information available (16 USC 1851(a)(2)). The EFH Final Rule (50CFR Part 600) contains guidance regarding the types and levels of information that should be used for describing and identifying EFH, mitigating fishing impacts and designating HAPCs. Where information is sparse, the Final Rule directs that FMPs identify data gaps and recommend research to acquire necessary information. The guidelines also require that information be used in a risk-averse fashion to ensure adequate protection of habitat for all species in the management units.

2.1.2.2 Compliance with NEPA

NEPA is the basic national charter for protection of the environment. It establishes policy, sets goals and provides means for carrying out the policy. The purpose of the regulations is to tell Federal agencies what they must do to comply with the procedures and achieve the goals of the Act. The President, the Federal agencies, and the courts share responsibility for enforcing the Act.

NEPA procedures must ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA. Most important, NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment.

The National Environmental Policy Act requires treatment of incomplete or unavailable information in an EIS. Under the CEQ regulations (1502.22), when information is incomplete or unavailable, it is to be obtained if costs are not exorbitant. If the information cannot be obtained, the EIS must:

- State that the information is incomplete or unavailable
- State the relevance of the information to the analysts' ability to evaluate reasonably foreseeable significant effects
- Summarize credible scientific evidence about likely impacts
- Use methods generally accepted by the scientific community for extrapolating, modeling, predicting and so forth

Because information is incomplete for most species covered in the fishery management units covered by the EIS, the document has inferred distribution of species and life stages from habitat utilization (see Section 2.1.3). The inferences have been applied broadly, in a precautionary manner, to assure inclusion of all utilized habitat. The scientific community deals with this type of data paucity by applying best practices, expert opinion, and inferences from known information such as catch per unit effort and landings data. The inferences on fish distribution made from habitat distribution constitute best practices. The level of uncertainty arising from the absence of this information has been mitigated by development of alternatives that are risk averse.

2.1.2.3 Compliance with the Data Quality Act

Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 directed the Office of Management and Budget (OMB) to issue government-wide guidelines that provide policy and procedural guidance to Federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information disseminated by Federal agencies to the public. Section 515 is known as the Data Quality Act.

Pursuant to Section 515 of Public Law 106-554 (the Data Quality Act), this information product has undergone a pre-dissemination review by the Southeast Region Habitat Conservation Division. The signed Pre-dissemination Review and Documentation Form is on file in that office.

2.1.3 Describing and identifying EFH

2.1.3.1 Introduction

The M-S Act defines essential fish habitat as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (M-S Act § 3(10)). This defines EFH, but does not specify how to distinguish among various parts of a species' range to determine the portion of the range that is essential. The EFH Final Rule (50CFR Part 600) elaborates that the words "essential" and "necessary" mean identification of sufficient EFH to "support a population adequate to maintain a sustainable fishery and the managed species' contributions to a healthy ecosystem."

The process of distinguishing between all habitats occupied by managed species and their EFH requires one to identify some difference between one area of habitat and another. In essence, there needs to be a characterization of habitats and their use by managed species that contains sufficient contrast to enable distinctions to be drawn, based on available information. This needs to be a data driven exercise, and this EIS used all available data with which to make such a determination.

In this context, we also note that if a species is overfished and habitat loss or degradation may be contributing to the species being identified as overfished, all habitats currently used by the species may be considered essential. In addition, certain historic habitats that are necessary to support rebuilding the fishery and for which restoration is technologically and economically feasible may also be considered as essential. Once the fishery is no longer considered to be overfished, the EFH identification should be reviewed and amended, if appropriate (EFH Final Rule CFR 600.815(a)(1)(iv)(C)). A list of the Gulf of Mexico species that are considered overfished or experiencing overfishing is provided in Section 3.2.4. Fish stocks depleted by overfishing, or by other factors, tend to not use as much of the available habitat as a virgin stock or a stock at optimum biomass would use. The picture is complex, however, because other species may have expanded their range to fill some of these ecological niches.

Habitat characteristics comprise a variety attributes and scales, including biological, physical (geological), and chemical parameters, location, and time. Ecologically, species distributions are affected by characteristics of habitats that include obvious structure or substrate (e.g., coral reefs and marshes) and other structures that are less distinct (e.g., turbidity zones, thermoclines, or fronts separating water masses). Fish habitat utilized by a species can change with life history stage, abundance of the species, competition from other species, environmental variability in time and space and human induced changes. Occupation and use of habitats by fish may change on a wide range of temporal scales: seasonally, inter-annually, inter-decadal (e.g. regime changes), or longer. Habitat not currently used but potentially used in the future should be considered when establishing long-term goals for EFH and species productivity. Habitat restoration is a vital tool to recover degraded habitats and improve habitat quality and quantity, enhancing benefits to the species and society.

Fish species rely on habitat characteristics to support primary ecological functions comprising spawning, breeding, feeding and growth to maturity. Important secondary functions that may form part of one or more of these primary functions include migration and shelter. Most habitats provide only a subset of these functions. The type of habitat available, its attributes, and its functions are important to species productivity and the maintenance of healthy ecosystems.

According to the M-S Act, EFH must be designated for the fishery as a whole (16 U.S.C. §1853(a)(7)). The final rule clarifies that every FMP must describe and identify EFH for each life stage of each managed species. As further clarification, NOAA General Counsel has stated that "Fishery" as used in the M-S Act in reference to EFH refers to the FMU of an FMP. This EIS therefore develops alternatives for EFH based on individual species/life stages aggregated to a single EFH designation for each of the seven FMPs for the Gulf of Mexico. In the EIS, a single map for each FMP is used to describe and identify EFH for each fishery. However, the analysis that produced those maps included the preparation of electronic maps of EFH for as many species and life stages as possible.

Designation of EFH for a fishery is therefore achieved through an accounting of the habitat requirements for all life stages of all species in the FMU. Prior to designating EFH for a fishery, the information about that fishery therefore needs to be organized by individual species and life stages. If data gaps exist for certain life stages or species, the EFH Final Rule suggests that inferences regarding habitat usage be made, if possible, through appropriate means. For example, such inferences could be made on the basis of information regarding habitat usage by a similar species or another life stage (50 CFR 600.815(a)(iii)). All efforts must be made to consider each species and life stage in describing and identifying EFH for the fishery and to fill in existing data gaps using inferences prior to determining that the EFH for the fishery does not include habitats for the species or life stage in question. As explained in Section 2.1.2, the CEQ Regulations mandate a process for dealing with incomplete or unavailable information

While describing and identifying EFH is carried out at the fishery (FMP) level, the determination of whether an area should be identified as EFH depends upon habitat requirements at the level of individual species and life stages. Potentially, only one species/life stage in the FMU may be required to describe and identify an area as EFH for the FMP. Many areas of habitat, however, are likely to be designated for more than one species and life stage. The EFH for FMPs that contain a large number of widely distributed species (such as the Reef Fish FMP), are likely to result in large areas of habitat being described and identified as EFH, due to overlay of multiple species/life stage habitat needs.

2.1.3.2 Use of information

The EFH Final Rule explains that the information necessary to describe and identify EFH should be organized at four levels of detail, level 4 being the highest and level 1 the lowest:

- Level 4 – production rates by habitat are available
- Level 3 – growth, reproduction, or survival rates within habitats are available
- Level 2 – habitat-related densities of the species are available; and
- Level 1 – distribution data are available for some or all portions of the geographic range of the species.

The text table below provides additional detail on the meanings to be inferred from this list.

Layer	Possible units/information sources
Level 4: Production rates	Overall production rates can be calculated from growth, reproduction and survival rates. However, using this information to describe and identify EFH requires not only that production rates have been calculated, but also that they have been calculated for different patches of habitat that can then be distinguished from each other. According to the EFH Final Rule, at this level, data are available that directly relate the production rates of a species or life stage to habitat type, quantity, quality, and location. Essential habitats are those necessary to maintain fish production consistent with a sustainable fishery and the managed species' contribution to a healthy ecosystem.
Level 3: Growth, reproduction or survival rates	Similar to information on overall production rates; growth, reproduction, and survival rates can be used to describe and identify EFH. Growth, reproduction and survival rates would need to have been calculated for different patches of habitat that can then be distinguished from each other. According to the EFH Final Rule, at this level, data are available on habitat-related growth, reproduction, and/or survival by life stage. The habitats contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life stage).

Layer	Possible units/information sources
Level 2: Density	Relative density information may be available from surveys, or it could perhaps be inferred from catch per unit effort data, although only for those areas that have been fished. According to the EFH Final Rule, at this level, quantitative data (i.e., density or relative abundance) are available for the habitats occupied by a species or life stage. Because the efficiency of sampling methods is often affected by habitat characteristics, strict quality assurance criteria should be used to ensure that density estimates are comparable among methods and habitats. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value. When assessing habitat value on the basis of fish densities in this manner, temporal changes in habitat availability and utilization should be considered.
Level 1: Distribution	Distribution information is available from surveys, catch/effort data, and evidence in the biological literature, including ecological inferences (e.g. - a habitat suitability index, HSI). According to the EFH Final Rule, distribution data may be derived from systematic presence/absence sampling and/or may include information on species and life stages collected opportunistically. In the event that distribution data are available only for portions of the geographic area occupied by a particular life stage of a species, habitat use can be inferred on the basis of distributions among habitats where the species has been found and on information about its habitat requirements and behavior. Habitat use may also be inferred, if appropriate, based on information on a similar species or another life stage.

The EFH Final Rule requires using the highest level of information (production rates) first (if available), followed by the second highest level (growth, reproduction or survival rates) and so on. The guidelines also call for applying this information in a risk-averse fashion to ensure adequate areas are protected as EFH. The most complete information available should be used to determine EFH for each species and life stage. If higher level information is available only for a portion of the species/life stage range then a decision needs to be made regarding how the information should be used – for example can the knowledge from the portion of the range covered be extrapolated to the rest of the range? In accordance with the requirement to use the highest level of detail available, the highest-level information should be used for the portion of the species/life stage range for which it is available, or to which the information could be validly extrapolated. Information at lower levels should be used only where higher-level information is unavailable and cannot be validly extrapolated.

If only Level 1 information is available, distribution data should be evaluated (e.g., using a frequency of occurrence or other appropriate analysis) to identify EFH as those habitat areas most commonly used by the species. Information at levels 2 through 4, if available, should be used to identify EFH as the habitats supporting the highest relative abundance; growth, reproduction, or survival rates; and/or production rates within the geographic range of a species. FMPs should explain the analyses conducted to distinguish EFH from all habitats potentially used by a species. Such analyses should be based on geo-referenced data that show some areas as more important than other areas, to justify distinguishing habitat and to allow for mapping. The data must at least show differences in habitat use or in habitat quality that can be linked to habitat use.

At the level of individual species and life stages, there is an implicit link between the level of information available and the extent of the total range of habitat of the species/life stage that is designated as EFH. This is illustrated in Figure 2.1.1. This graphical representation is not intended to be to scale. It shows, however, that the maximum area designated as EFH is based on distribution data (level 1) – i.e. this would be the case if the only information available for the species and life stage in question were its overall distribution. In this case there would be no scientific basis for distinguishing between the EFH of the species/life stage and all the habitats that it occupies. If more detailed information is available, however, for example at level 2 or higher, it becomes possible to show differences between parts of the total range of the species/life stage, enabling parts of the range to be identified as EFH. As the available information becomes more detailed, so the level of contrast in the data grows and the likelihood that a smaller area can be identified as EFH increases. This relationship between the level of available information and the portion of the total range identified as EFH is in accordance with the risk-averse approach required by the EFH Final Rule. The result of having only poor information available is a more inclusive identification of EFH. If better information is available, then it may be possible to be more exclusive, without potentially failing to identify areas of habitat as EFH that are really should be EFH.

If no information for a species/life stage is available at the lowest level (distribution) and it is not possible to infer distribution from other species or life stages, then EFH cannot be identified for that species (600.815(a)(1)(iii)(B)). CEQ regulations (1502.22) require agencies to make clear when information is lacking.

2.1.3.3 Available information

There are two main types of information available that can be used to describe and identify EFH:

- Empirical geo-referenced data on species distributions, densities, and/or productivity rates derived from analyses of surveys and commercial catches. These data are essentially independent of the underlying habitat.

- Information about associations and functional relationships between species/life stages and habitat that can be used to make inferences about species distributions, density and/or productivity rates, based on the distribution of habitat.

Information at all four of the levels of detail described in the EFH Final Rule may exist in both of these categories. Examples of such are provided in the following text table:

	Empirical geo-referenced information	**Species-Habitat relationship modeling**
Level 4 – production rates by habitat	*In situ* physiological experiments and mortality experiments	Life history-based meta-population models
Level 3 – growth, reproduction, or survival rates within habitats	Tagging data (growth) Fecundity data by area	Spatially discreet stock/recruitment relationships; Bio-energetic models

Level 2 – habitat-related densities of the species	Survey/fishery related CPUE as proxy for density	Spatial modeling of probability of occurrence, or other forms of HSM
Level 1 – distribution data	Surveys presence/absence	Simple habitat-species associations

Virtually no information at levels 3 and 4 exists for managed species in the Gulf of Mexico, and none that could be used to distinguish between different areas of habitat with sufficient contrast to indicate that one should be identified as EFH and the other should not.

The information available in each of these categories is elaborated in more detail in the following sections.

2.1.3.3.1 Empirical spatial data

2.1.3.3.1.1 Types of data and their utility

Empirical spatial data are provided by direct and indirect observations of fish distribution, density, or rates (growth, reproduction, survival, production). Fishery-independent surveys such as SEAMAP and fishery-dependent data sets such as port sampling programs most typically provide these types of data. Surveys are inherently geo-referenced, in that all data have an association with a location. Port sampling programs and fishery logbooks may not collect location data, or may collect location data at various scales. Summary data collected by statistical area have a more coarse distribution scale than data collected by latitude and longitude of fishing location (i.e. haul by haul).

Entering geo-referenced data into a Geographic Information System (GIS) computer system allows spatial analysis of information. Ideally, the data collection covers the entire range of a species or life stage (or at least the portion of that entire range that is of interest to the study). As the geographic area of data collection is reduced, so the extent to which it represents the whole range falls, limiting the conclusions that can be drawn from the data.

Surveys and catch data collection provide potentially useful information for determining the distribution and abundance of fish, but the data they collect can have important limitations when being used to delineate the extent of EFH. Although they are frequently used to indicate the presence of fish and estimate their relative abundance, survey and catch data often provide little or no information on the underlying habitat at the sampling or catch locations (other than depth). In addition, they tend to target limited life stages (usually the adults) and usually target only commercially or recreationally important species. Commercial data in particular are almost always spatially non-random (focusing only on the areas and times when the fish can be most easily caught), and as such limit the inferences that can be drawn with respect to spatial patterns. Distribution of catch by area may provide an index of density, on the assumption that fishers target areas with highest density to obtain highest catch rates. However, several factors reduce the utility of this approach. Fishers may preferentially fish closer to port in lower density areas to save transit time and cost. Areas offshore would therefore be under sampled. Also, more abundant/higher density species may have lower value than less dense species.

2.1.3.3.1.2 Sources of empirical spatial data

Despite the inherent limitations of some types of data, the project team sought and used as much information as possible to describe the distribution, density, and habitat uses of species and life stages over the entire Gulf of Mexico. The team particularly sought out information in a GIS-compatible form, or in a form that could be converted to a GIS format within the time frame of this project. Using a GIS format was the only way to integrate and analyze information on habitats, habitat use by managed species / life stages and fishing effort by multiple gears in the time available for the EIS. Also, GIS is the most effective and efficient way to use spatial information and is encouraged by the EFH Final Rule to satisfy the EFH mapping requirement.

The first and most obvious source of data on species distribution and density for this EIS was the 1998 Generic Amendment. This document contains 33 maps of distribution for 21 different species in the seven FMPs. These maps resulted from collaboration between the National Ocean Service (NOS) of NOAA, NOAA Fisheries, and the Gulf Council.

NOS staff analyzed data to determine relative abundance of the mapped species by estuary, salinity zone, and month. The maps show relative abundance plotted in the calendar-season salinity contours using a relationship between relative abundance and salinity. Salinity was used as a proxy for fish abundance and distribution (John Christensen, NOS, personal communication) because this was the only metric with a strong correlation with fish distribution that was consistently available across the GOM. The data analyzed to produce the maps included fishery independent data sets for the GOM, including SEAMAP and state trawl surveys, and data from the Estuarine Living Marine Resources (ELMR) Program. The latter data contain information on relative abundance (highly abundant, abundant, common, rare, not found, and no data) for a series of estuaries, by five life stages (adult, spawning, egg, larva, and juvenile) and month for five seasonal salinity zones (0-0.5, 0.5-5, 5-15, 15-25, and >25). The NOS provided salinity maps of the estuaries by season and region (Texas, Louisiana/Mississippi/Alabama, and Florida).

Images of these maps were available from two sources:

- as electronic files in PDF (portable document format), downloadable from the NOAA Fisheries Galveston EFH web site at http://galveston.ssp.nmfs.gov/efh/changes/default_new.htm#Abundance_maps

- as hard copy images from the 1998 Generic Amendment.

A list of all the maps that are available from these two sources is provided in Appendix C.

Neither the PDF computer files nor the hard copy images from the 1998 Generic Amendment were suitable for analytical purposes due to their relatively low quality. The current EIS used GIS technology to plot and analyze geographic information to identify and develop maps of EFH and investigate threats to EFH from fishing and other sources. The project team attempted to obtain from NOS the GIS shape files that were used to generate the original maps, but these could not be made available by NOS within the timeframe of the project. Therefore, this information on species distribution could not be used in the analytical procedure for identifying EFH.

Several alternative sources of species distribution information were investigated. The first of these was a data set obtained from SL Ross Environmental Research Limited (Canada). These data were generated as part of a private contract between the Marine Industry Group and SL Ross Ltd. titled *An Oil Spill Impact Assessment System and Guide to Dispersant-Use Decision Making for the U.S. Gulf of Mexico and the Atlantic Coast of Florida* (Marine Industry Group, January 1989). The data comprise 68 maps covering 12 managed species in six of the seven FMPs (nothing for coral): red drum (8 maps), scamp (3 maps), mangrove snapper (5 maps), red snapper (13 maps), king mackerel (5 maps), Spanish mackerel (7 maps), cobia (7 maps), white shrimp (5 maps) brown shrimp (5 maps), pink shrimp (5 maps), stone crab (1 map), spiny lobster (4 maps). In addition to these maps for Federally managed species, there is also a map for sturgeon.

During the preparation of the EIS, the project team attempted to obtain the metadata necessary to validate the maps to allow them to be used in the identification of EFH. The required metadata were not readily available and to expedite the process, the Florida Marine Research Institute (FMRI) provided funding for them to be produced. However, at the time of final preparation of the EIS, the metadata were not yet available and therefore could not be used in the analysis.

In the absence of readily available species distributions in a GIS format, the project team considered analyzing the original data from the SEAMAP (Southeast Area Monitoring and Assessment Program) surveys to create new maps. SEAMAP is a state/Federal/university program for the collection, management and dissemination of fishery-independent data and information in the southeastern United States. The overall program consists of three operational components: SEAMAP-Gulf of Mexico (begun in 1981); SEAMAP-South Atlantic (implemented in 1983); and SEAMAP-Caribbean (formed in 1988). The SEAMAP-Gulf component is coordinated through the Gulf States Marine Fisheries Commission. SEAMAP resource surveys include the Fall Shrimp/Groundfish Survey, Spring Plankton Survey, Reef Fish Survey, Summer Shrimp/Groundfish Survey, Fall Plankton Survey and plankton and environmental surveys. Publications of the SEAMAP program include environmental and biological atlases of the Gulf of Mexico for each year from 1983 through present. These atlases show distributions for a few FMP species in terms of point data. They do not represent GIS shape files of the type required for the analysis in this EIS.

The time frame of the EIS preparation did not allow for the required analytical effort to convert the SEAMAP survey results into interpolated distribution and/or density polygons in a GIS. Even if time allowed, SEAMAP sampling does not cover all areas of FMP species distribution in the Gulf of Mexico. The project team decided not to analyze the SEAMAP data at this stage.

2.1.3.3.1.3 Empirical spatial data used in the analysis

Having tried unsuccessfully to use other data sources, the project team investigated the potential of using the NOAA Gulf of Mexico Coastal and Ocean Zones Strategic Assessment Data Atlas (NOAA 1985, hereafter referred to as the NOAA Atlas). This atlas provides an important source of species distribution and density information for the Gulf of Mexico. A total of 36 life stages covering 28 species, are depicted in the atlas (see following list).

The following is a list of species and life stages covered by the Gulf of Mexico FMPs that are included in the NOAA Atlas.

Red Drum FMP (1)

Red drum	*Sciaenops ocellatus*	*juvenile, adult, spawning adult*

Reef Fish FMP (9)

Carangidae—Jacks (1)

Greater amberjack	*Seriola dumerili*	*adult*

Lutjanidae—Snappers (6)

Mutton snapper	*Lutjanus analis*	*juvenile, adult*
Red snapper	*Lutjanus campechanus*	*juvenile, adult*
Gray (mangrove) snapper	*Lutjanus griseus*	*juvenile, adult*
Lane snapper	*Lutjanus synagris*	*juvenile, adult*
Yellowtail snapper	*Ocyurus chrysurus*	*juvenile, adult*
Vermilion snapper	*Rhomboplites aurorubens*	*juvenile, adult*

Serranidae—Groupers (2)

Black grouper	*Mycteroperca bonaci*	*adult*
Red grouper	*Epinephelus morio*	*adult, spawning adults*

Coastal Migratory Pelagic FMP (3)

King mackerel	*Scomberomorus cavalla*	*adult*
Spanish mackerel	*Scomberomorus maculatus*	*adult, spawning adults*
Cobia	*Rachycentron canadum*	*juvenile, adult*

Shrimp FMP (4)

Brown shrimp	Farfantepenaeus aztecus *(Penaeus aztecus)*	*juvenile, adult*
White shrimp	Litopenaeus setiferus *(Penaeus setiferus)*	*juvenile, adult, spawning adults*
Pink shrimp	Farfantepenaeus duorarum *(Penaeus duorarum)*	*juvenile, adult*
Royal red shrimp	*Hymenopenaeus robustus (Pleoticus robustus)*	*adult*

Stone Crab FMP (1)

Stone Crab	*Menippe mercenaria*	*juvenile, adult*

Spiny Lobster FMP (1)

Spiny lobster	*Panulirus argus*	*juvenile, adult*

The compilers of the NOAA Atlas made a special effort to identify both the entire range of species and areas where species were considered to be relatively more abundant. The compilers identified the areas in which the number of individuals per unit area is significantly higher than in other areas, or in which the fishing activity is relatively concentrated in terms of numbers of fish caught per unit area. The full range of species abundance categories is as follows:

- Juveniles: Major nursery area, Nursery area
- Adults: Major adult area, Adult area, Major adult concentration, Major commercial fishing ground, Major adult area and commercial fishing ground, Commercial fishing ground, Commercial and recreational fishing ground, Recreational fishing ground, Occurrence, Rare occurrence
- Spawning Adults: Spawning area

(Note: Some of these categories have specific seasons associated with them for some species)

Description of 1985 NOAA Atlas density/distribution categories	
Atlas category	**Category description**
Spawning area	An area in which courting, mating, spawning, fertilization, and other reproductive activities of a species occur
Adult area	An area where sexually mature individuals of a species occur or congregate
Major adult area	An area where sexually mature individuals of a species occur or congregate, and are relatively more abundant than in other adult areas they occupy
Commercial fishing ground	An area in which a species is harvested for its economic value
Major commercial fishing ground	An area in which a species is harvested for its economic value, and where fishing activity is relatively concentrated in terms of numbers of fish caught per unit area
Recreational fishing ground	An area which supports a recreational or sport fishery directed to a particular species
Major recreational fishing ground	An area which supports a recreational or sport fishery directed to a particular species, and where fishing activity is relatively concentrated in terms of numbers of fish caught per unit area
Nursery area	An area where young stages (juveniles) of a species occur or concentrate for feeding and/or refuge

Major nursery area	An area where young stages (juveniles) of a species are relatively more abundant than in other nursery areas they occupy
Occurrence	An area which a species is known to inhabit, but where the species is relatively less abundant than in other parts of its distribution
Rare Occurrence	An area which a species is known to inhabit, but at abundances well below those found in other parts of its distribution
Note: Areas of abundance (i.e. "major" areas) are shown only where clear evidence indicated their existence.	
Note: The absence of a "major" label for a category does not imply that the species is evenly distributed throughout its range, only that information was insufficient to map the preferred areas clearly.	

This list of possible categories, some of which are used with some species and some with others, did not allow the selection of a single category that defines areas of higher abundance across all species. In general, areas of higher abundance are indicated by the "major" categories. However, in some cases no major category is indicated. As a general rule, the area of highest relative density was assumed to be the major category where available. Wherever this was not possible, the area of the commercial fishery (if available) was used[1]. In some cases it was not possible to infer a higher density in one part of the species/life stage range compared to another (see text table below).

Map categories in the 1985 NOAA Atlas for Gulf of Mexico FMP species

Species	Life Stage	All distribution categories	Highest density category
Red Drum FMP			
Red drum	Juveniles	Nursery area	Not Available
	Adults	Adult area, Commercial and recreational fishing grounds, Recreational fishing grounds	Commercial and recreational fishing grounds
	Spawning adults	Spawning area	Not Available
Reef Fish FMP			
Greater amberjack	Adult	Adult area, Commercial fishing grounds	Commercial fishing grounds
Mutton snapper	Juveniles	Nursery area	Not Available
	Adults	Adult area, Commercial fishing grounds, Recreational fishing grounds, Occurrence	Commercial fishing grounds
Red snapper	Juveniles	Nursery area	Not Available

[1] Using the commercial fishery as a proxy for higher density suffers from the limitations of using commercial CPUE information that were described earlier in this section. However, in these cases, this was the only method available to distinguish between all habitats potentially occupied by the species and their EFH (i.e the higher density area).

Species	Life Stage	All distribution categories	Highest density category
	Adults	Major adult area, Adult area, Commercial fishing grounds, Recreational fishing grounds	Major adult area
Gray snapper	Juveniles	Nursery area	Not Available
	Adults	Major adult area, Adult area, Commercial fishing grounds, Recreational fishing grounds	Major adult area
Lane snapper	Juveniles	Nursery area	Not Available
	Adults	Adult area, Commercial fishing grounds, Recreational fishing grounds	Commercial fishing grounds
Yellowtail snapper	Juveniles	Nursery area	Not Available
	Adults	Major adult area, Adult area, Major commercial fishing grounds, Commercial fishing grounds, Recreational fishing grounds, Occurrence	Major adult area, Major commercial fishing grounds
Vermilion snapper	Juveniles	Nursery area	Not Available
	Adults	Adult area, Commercial fishing grounds, Recreational fishing grounds	Commercial fishing grounds
Golden tilefish	Adults	Adult area	Not Available
Red grouper	Adults	Adult area, Major commercial fishing grounds, Commercial fishing grounds, Occurrence	Major commercial fishing grounds
	Spawning adults	Spawning area	Not Available
Black grouper	Adults	Adult area, Commercial fishing grounds, Occurrence	Commercial fishing grounds
Coastal Migratory Pelagics FMP			
King mackerel	Adults	Adult area, Commercial fishing grounds, Recreational fishing grounds	Commercial fishing grounds
Spanish mackerel	Adults	Adult area, Commercial fishing grounds, Recreational fishing grounds	Commercial fishing grounds
	Spawning adults	Spawning area	Not Available
Cobia	Juveniles	Nursery area	Not Available
	Adults	Major adult area, Adult area	Major adult area

Species	Life Stage	All distribution categories	Highest density category
Shrimp FMP			
Brown shrimp	Juveniles	Major nursery area, Nursery area	Major nursery area
	Adults	Major adult area, Adult area, Major adult area and commercial fishing grounds, Major commercial fishing grounds	Major adult area, Major adult area and commercial fishing grounds, Major commercial fishing grounds
White shrimp	Juveniles	Nursery area	Not Available
	Adults	Major adult area, Adult area, Major adult concentration, Commercial fishing grounds	Major adult area, Major adult concentration
	Spawning adults	Spawning area	Not Available
Pink shrimp	Juveniles	Major nursery area, Nursery area	Major nursery area
	Adults	Adult area, Major commercial fishing grounds, Commercial fishing grounds	Major commercial fishing grounds
Royal red shrimp	Adults	Major adult area, Adult area	Major adult area
Stone Crab FMP			
Stone crab	Juveniles	Nursery area	Not Available
	Adults	Major adult area, Adult area, Commercial fishing grounds	Major adult area
Spiny Lobster FMP			
Spiny lobster	Juveniles	Nursery area	Not Available
	Adults	Rare occurrence, Occurrence, Commercial fishing grounds	Commercial fishing grounds

In order to use the spatial information in the NOAA Atlas, the maps had to be converted into a GIS format. Each of the relevant hardcopy map pages in the NOAA Atlas was scanned to a high resolution (300dpi) TIFF image. Each digital image then underwent a registration process called geo-rectification. This process associates several locations on the image to known coordinates in the GIS. Geo-rectification allows an image to be displayed within a GIS environment in its correct geographic position (e.g. The shoreline of the image aligns with the shoreline in the GIS). Once georectified, the polygonal data were digitized from the images to create digital distribution and density data for each species. The digitized polygons were converted to GIS layers (ESRI Shapefiles) and incorporated into the GIS for further analysis.

2.1.3.3.2 Spatial and functional relationships between managed species and habitats

2.1.3.3.2.1 Modeling approaches

Habitat suitability models (HSM) may be used to infer species distributions based on the locations of suitable mapped habitat associated with each species and life stage. HSM provides a mechanism to predict the locations of suitable habitat, based on the habitat preferences of individual species or species groups.

Habitat characteristics comprise a variety of attributes and scales, including biological, physical (geological), and chemical parameters, location, and time. It is the interactions of environmental variables that make up habitat that determine a species' biological niche. These variables include both physical variables such as depth, substrate, temperature range, salinity, dissolved oxygen, and biological variables such as the presence of competitors, predators, prey or facilitators.

Species distributions are affected by characteristics of habitats that include obvious structure or substrate (e.g., reefs and marshes) and other structures that are less distinct (e.g., turbidity zones, thermoclines, or fronts separating water masses). Fish habitat utilized by a species can change with life history stage, abundance of the species, competition from other species, environmental variability in time and space, and human induced changes. Occupation and use of habitats by fish may change on a wide range of temporal scales: seasonally, inter-annually, inter-decadal (e.g. regime changes), or longer. Habitat not currently used but potentially used in the future should be considered when establishing long-term goals for EFH and species productivity. Habitat restoration will be a vital tool to recover degraded habitats and improve habitat quality and quantity, enhancing benefits to the species and society.

Fish species rely on habitat characteristics to support primary ecological functions comprising spawning, breeding, feeding and growth to maturity. Important secondary functions that may form part of one or more of these primary functions include migration and shelter. Most habitats provide only a subset of these functions. The type of habitat available, its attributes, and its functions are important to species productivity and the maintenance of healthy ecosystems.

It may therefore be possible to infer species distribution (a probability of occurrence) based on the distribution of suitable habitat. Biological, geological and hydrological data, such as substrate, vegetation, temperature, salinity, and depth, are subjected to multivariate analyses to classify the community of fishes associated with various portions of environmental gradients. This methodology has been employed in the Gulf of Mexico region to develop descriptive habitat utilization maps. Several efforts of limited geographic extent have been undertaken in the Gulf of Mexico region (Sheridan 1996; Rubec *et al*. 1998; Gallaway *et al.* 1999). However, in general, sufficient data currently do not exist to construct quantitative HSM for most managed species and life history stages in the Gulf of Mexico.

In the absence of quantitative HSM, basic information linking species to habitats can be used with habitat distribution information to infer species distributions and thereby identify EFH. For example, functional relationships between species and habitat can be inferred from a simple cartographic or GIS overlay of a species distribution layer with a habitat distribution layer, even if the respective layers are only available for part of the range of the species (provided, of course, that they do overlap). A species could be considered to be associated with all habitats that occur within the geographic range where it has been found. One can then make the assumption, in a precautionary sense, that a species uses that habitat wherever the habitat occurs within the region being studied. This is, however, likely to be a highly imprecise way of identifying EFH. There may be other factors besides the presence or absence of habitat, which determine the true distribution of a species/life stage (e.g. physical barriers, climatic factors, inter- and intra-specific competition, water quality, currents etc.).

The HSM approach, whether quantitative or qualitative, would benefit from direct sampling to confirm the predicted associations. A sampling program aimed at ground-truthing would demonstrate errors in the results of the HSM exercise, and would provide information for adjusting the model. More sophisticated models could include seasonal habitat associations, which allow targeting sampling to the most likely time to find the species. Less intensive sampling might be required to support simpler HSM.

The available information on relationships between managed species and habitats is in two main parts:

1. Use of habitat types by all species at all life stages where information exists or could be inferred (Appendix C and Section 3.2.4).
2. Spatial information on the distribution of habitat (Sections 3.2.1- 3.2.3)

Information under (1) is used to develop representations of the functional relationships between species/life stages and habitats. These functional relationships are then used to infer distributions and densities of species/life stages based on the distribution of habitats in the GIS (2). The specific methods used to complete this analysis for the EIS are described in the following sections.

2.1.3.3.2.2 Modeling habitat use

The information available on the functional relationships between species/life stages and habitats is largely qualitative. It may be possible to indicate what functions a species/life stage perform in a particular habitat, but it is not yet feasible to infer growth, reproductive, recruitment or overall production rates based on specific habitat conditions. Although *in situ* studies of bioenergetics provide a theoretical framework for relating growth rates (productivity) and feeding ecology to an organism's habitat and environmental conditions (Adams and Breck 1990), many difficulties arise in developing models for productivity of fish on a habitat basis. Consequently, it has seldom been attempted. Studies of this nature usually require that physiological measurements conducted in the field, be extrapolated in the context of known tendencies or "conventions" established in the laboratory. When bioenergetics models are designed to estimate production, the parameters of ingestion, metabolism and waste must be known or estimated so that growth may be determined. Although the amount of ingested energy is relatively easy to measure, metabolic rates in wild fish are difficult to estimate.

Fish physiology has been studied extensively in the laboratory. Published works by Winberg (1956), Fry (1957, 1971), Elliot and Davidson (1975), Brett and Groves (1979), Jobling and Davies (1980), Adams and Breck (1990), and Jobling (1994), among others, have delineated the factors influencing bioenergetics in fish. Although laboratory studies have established the basic physiological requirements for many species, it is important to note that these studies were conducted under controlled environmental conditions, which limit or eliminate many environmental factors found in an organism's natural habitat. Additionally, many of the fish observed in these studies were freshwater species or cold-water commercial species outside the southern Atlantic and US Caribbean. Consequently, much of the data may not be applicable to productivity issues for marine species in the Gulf of Mexico. Despite these challenges, a few authors have described aspects of fish physiology based on observations and experiments conducted in the field (Beaver 2002; DeMartini *et al*. 1994; Soofiani and Hawkins 1982; Polunin and Klumpp 1992).

The availability of information at levels 1 and 2 in this category is much better than at levels 3 and 4. The 1998 Generic Amendment contains information in 21 tables by species and life stage on substrate preferences and the ecological functions they support, preferences for water depth, salinity, and temperature, dissolved oxygen tolerances; known prey and predators, and qualitative information on geographic range. A further 27 tables were provided by NOAA Fisheries, Southeast Fisheries Science Center during the preparation of this EIS. The information they contain was derived from a comprehensive review of information in the scientific literature. Full lists of citations are included with these tables providing a referenced source for most pieces of information.

All of these tables are provided in Appendix C. Of the 55 species in the six FMUs (not including coral), tables are missing for only eight:

Vermilion snapper	*Rhomboplites aurorubens*
Goldface tilefish	*Caulolatilus chrysops*
Blackline tilefish	*Caulolatilus cyanops*
Anchor tilefish	*Caulolatilus intermedius*
Dwarf sand perch	*Diplectrum bivittatum*
Sand perch	*Diplectrum formosum*
Misty grouper	*Epinephelus mystacinus*
Marbled grouper	*Epinephelus inermis*

All available distribution and habitat association information for all species (including these) is summarized in Section 3.2.4. This information was transferred into a relational database designed specifically for this EIS (the habitat use database). The database was used to help organize the data and to analyze the relative importance of different habitats to the various individual FMU species and life stages and the FMU assemblages as a whole. The data are referenced in the database on a species/life stage basis. While there is some information for juvenile and adult life stages, there is a general lack of information existing on some of the earliest life history stages, particularly the postlarval stage. The database contains as much information as could be compiled during the time available for preparation of the EIS. It can also potentially hold data of the type that would fall into levels 3 and 4, however, there is currently no quantitative information available on differential growth, mortality, or production rates among Gulf of Mexico habitats for any FMP species.

Many text sources were used to compile the database, which included many different terms for describing different habitats. For purposes of analysis and mapping, these needed to be consolidated and made consistent. An important part of creating the database was therefore the definition of standard categories of habitat type. These habitat types were used to categorize the habitat preferences of managed species and also to describe the habitats mapped in the GIS. This standardization is vital to enable habitat preferences to be translated into potential species distributions and densities, and hence EFH, that can be mapped

The substrates and biogenic structures that make up the habitat were categorized in the database by zone and type. Habitat zone comprised three categories: estuarine (inside barrier islands and estuaries), nearshore (60 feet (18m) or less in depth) and offshore (greater than 60 feet (18m) in depth). Habitat type was subdivided into 12 categories distributed amongst the three zones. These 12 types were based on a combination of substrate and biogenic structure descriptions that was considered to provide the best overall categorization of fish habitats in the Gulf of Mexico. The table below presents this consolidated list of standard habitat types.

Habitat Type	**Related terms**
SAV	seagrasses, benthic algae
Mangroves	
Drifting algae	
Emergent marshes	tidal wetlands, salt marshes, tidal creeks, rivers/streams
Sand/shell bottoms	sand
Soft bottoms	mud, clay bottoms, silt
Hard bottoms	hard bottoms, live hard bottoms, low-relief irregular bottoms, high-relief irregular bottoms
Oyster reefs	
Banks/Shoals	
Reefs	reefs, reef halos, patch reefs, deep reefs
Shelf edge/slope	shelf edge, shelf slope
Pelagic	

Note: low-relief irregular bottoms include low ledges, caves, crevices, and burrows; high-relief irregular bottoms include high ledges & cliffs, boulders, and pinnacles.

2.1.3.3.2.3 Mapping habitat distribution

Using spatial and functional relationships between managed species and habitats to map species distribution and degrees of habitat use, and hence identify EFH, requires the locations of habitats to be mapped. This was done using a geographic information system (GIS) created specifically for the EIS project. A GIS is the most effective and efficient way to analyze and present spatial information (see Text Box).

Data on fish habitats were gathered from many different Federal and state sources. Data sources and methods used to collect, analyze and process information are described in detail in Appendix D.

A detailed map of bottom sediments for the Gulf of Mexico was constructed from data obtained from the Sheridan and Caldwell GOM Dataset CD-ROM (Pre-release Version) (see Appendix D). The full list of sediments was consolidated into the following sediment types:

Original Description	Summarized Description
Clay	Clay
Clayey Sand	Sand
Clayey Silt	Silt
Gravelly Sand	Sand
Hard Banks	Hard Bottom
Sand	Sand
Sand Silt Clay	Clay
Sandy Clay	Clay
Sandy Silt	Silt
Silt	Silt
Silty Clay	Clay
Silty Sand	Sand

The NOAA Atlas, besides containing information on species distribution and density, also contains maps of bottom sediments. These maps were digitized using the same procedure as described in Section 2.1.3.3.1.3. The resulting bottom sediments shapefile provided delineated sediment information to fill gaps in the Sheridan and Caldwell sediment data. NOAA Atlas sediment data provided polygons within the EEZ and in the estuarine environment.

These information sources together provided a complete sediment coverage map for the Gulf of Mexico. Sediment polygons from both shapefiles were incorporated into one shapefile and the boundaries between similar sediment types were dissolved [2]

Additional information on biogenic structures that constitute important components of habitat, was used to create the overall habitat map. This included spatial mapping of seagrass from FMRI and TNRIS, marshes from FMRI and USGS, mangroves from FMRI, oyster reefs from FMRI and TNRIS, and coral from FMRI. Each dataset was converted to Arc-Info Coverage and projected into Albers NAD83.

Sediment and habitat data from the sources described above were sometimes incomplete, inaccurate or inconsistent between data sets. The data were therefore subject to some manual adjustment to more accurately represent the fish habitat within the Gulf of Mexico. The polygons within the Flower Gardens from the Sheridan and Caldwell sediments that were coded as hard bottom were re-coded as coral. The hard bottom sediment polygon within Tampa Bay from the

[2] Dissolve is a GIS command that looks for adjacent polygons with the same attribute and removes the boundary between them to create one polygon.

NOAA Atlas was re-coded as sand. The coral patch west of the Tortugas from the NOAA Atlas was re-coded as hard bottom. The large hard bottom polygon off the West Florida coast depicted in the NOAA Atlas was determined to be a more accurate representation of sediment type in this area than that shown in the Sheridan and Caldwell data. The information from the NOAA Atlas was therefore used in this area. Coral habitat within the Dry Tortugas Ecological Reserve was missing from all datasets and was delineated using bathymetry from FMRI to represent Sherwood Forest and Riley's Hump.

The habitat map resulting from this work is discussed in Section 3.2.3.1.

The habitat descriptors in the GIS were matched up to the categories used in the database as follows:

Habitat Types in Database	**Matched Habitat Descriptors in GIS**
SAV	Seagrass
Mangroves	Mangroves
Emergent marshes	Marsh
Sand/shell bottoms	Sand
Soft bottoms	Clay, Silt
Hard bottoms	Hard bottom
Oyster reefs	Oyster reefs
Reefs	Coral
Banks/Shoals	Not mapped
Shelf edge/slope	Not mapped
Pelagic	Not mapped
Drifting algae	Not mapped
Artificial structures	Not mapped

Where EFH extends up to the estuarine/freshwater interface, National Wetlands Inventory (NWI) data are were used to delineate the landward boundary of EFH for the entire Gulf region (see Section 3.2.1). The boundary was developed by the NOAA/NESDIS/NODC/National Coastal Data Development Center using five NWI data sets, one from each Gulf state, Alabama, Florida, Mississippi, Louisiana, and Texas. The NWI is the result of the Emergency Wetland Resources Act of 1986, which directed the U.S. Fish and Wildlife Service to produce a digital wetlands database for the U.S. The NWI program has therefore been collecting, analyzing, digitizing, and archiving wetland data since 1986.

For the inland boundary of EFH, all data that has been identified as marine or estuarine have been captured into one GIS overlay. The areas depicted in the dark gray category, titled intertidal estuary displays only those E2 (intertidal estuary) subsystem. All other E (estuarine), R (riverine), L (lacustrine), and M (marine) categories are displayed in white. Non-marine systems such as U (uplands) and P (palustrine marsh) are in light gray category and would not be considered EFH. Intertidal estuary (E2) is defined as areas where the substrate is exposed and flooded by tides; and includes the associated splash zone.

A Primer on Geographic Information Systems

At its simplest level, a GIS is a sophisticated computer system capable of holding and displaying databases describing places and activities on the earth's surface to "paint a picture" of complex scenarios. Given that the majority of information pertaining to the marine environment has a spatial component, GIS and related geoprocessing technologies such as the global positioning system (GPS) and remote sensing provide a means to aggregate and analyze the data generated by disparate sources. GIS technology is rapidly replacing the traditional cartographic techniques that have typified most coastal mapping and resource inventory projects, and application to coastal and marine research and management efforts occurs worldwide.

A GIS is not simply a computer system for making maps, although it can create maps at different scales, different sizes, and with different colors and symbols. A GIS does not store a map in any conventional sense, nor does it store a particular image or view of a geographic area. Instead, a GIS stores the data from which the user can draw a desired view to suit a particular purpose. A GIS is also an analytical tool that allows the user to pose very complex questions to the computer, and receive answers in easy-to-interpret map form. The GIS database is a collection of spatial and tabular data depicting the location, extent, and characteristics of geographic features.

A GIS allows users to answer questions that deal with issues of location, condition, trends, patterns, and strategic decision-making, such as Where is it?; What patterns exist?; What has changed since...?;; What if...? It comprises layers of information occupying the same space so that users can rapidly analyze multiple conditions over wide areas. What a GIS cannot do, however, is generate scales of information that do not already exist in the input data. The scale of the data that are used to create it fundamentally limits the scale of information that a GIS can analyze and display.

2.1.3.3.2.4 Inferring species distribution and density based on functional relationships with habitat

Two of the key physical features that determine the suitability of habitat for managed species are substrate type and depth. Both of these habitat characteristics are mapped in the GIS (Section 2.1.3.3.2.3), and the depth and substrate preferences of most of the species and life stages in the Gulf of Mexico FMPs are recorded in the habitat use database (Section 2.1.3.3.2.2). This information is also provided in tables presented in Section 3.2.4. For each species and life stage, suitable habitat was mapped in the GIS according to these preferences; i.e. if a species and life stage was recorded as being associated with a particular substrate, then all occurrences of that substrate within the depth range of that species/life stage were recorded as being potential habitat for that species/life stage. Depth contours available in the GIS were every 5 fathoms out to 50 fathoms, 100 fathoms and 1,000 fathoms. If a species depth limits did not coincide with one of the contours available then the next shallowest (the lower end of the range) or next deepest (upper end of the range) was used. The allocation of potential habitat based on functional relationships was done out to the 100 fathom contour.

Applying this approach Gulf-wide provides a very imprecise representation of the distribution of managed species. It also provides no information on relative density that might be used to distinguish between all habitats occupied by a species, and those that should be identified as EFH. In order to refine the analysis, the Gulf of Mexico was therefore subdivided into five sub-units or "eco-regions". The division between the eco-regions was based primarily on logical eco-system subdivisions of the Gulf of Mexico. For convenience, the actual lines dividing the eco-regions were selected to coincide with existing boundaries between units in the NOAA Fisheries statistical grid (Figure 2.1.3) system for depicting fishing effort (Section 2.1.5.2.1).

Eco-region		**NOAA Fisheries Statistical Grid Units**
Eco-region name	**Bounds**	
1. South Florida	Florida Keys to Tarpon Springs	1-5
2. North Florida	Tarpon Springs to Pensacola Bay	6-9
3. East Louisiana, Mississippi and Alabama	Pensacola Bay to the Mississippi Delta	10-12
4. East Texas and west Louisiana	Mississippi Delta to Freeport	13-18
5. West Texas	Freeport to the Mexico border	19-21

The boundary between eco-regions 1 and 2 represents the approximate boundary between the West Indian and Louisianan biogeographic provinces in the Eastern Gulf (Cowardin *et al*. 1979). Eco-region 1 has a greater amount of subtropical influence and associated marine fauna, and a larger proportion of reefs, hard bottom, and mangroves than eco-region 2, which has an increased temperate influence, especially inshore (Hoese and Moore 1977).

The boundary between eco-regions 2 and 3 represents the boundary between an area of the northeastern Gulf that is less impacted by the influence of the Mississippi and Atchalafaya Rivers (eco-region 2), and an area that is heavily impacted by the river (eco-region 3). Eco-region 2 has hard bottom, sandy, and SAV habitats that are rare in eco-region 3. The majority of river water and accompanying fine sediments drift to the west rather than the east. Eco-region 3 has mostly soft bottom habitats, and greater amounts of marsh, and oyster reef habitats, and is more subject to salinity fluctuations in the nearshore than eco-region 2 (Hoese and Moore 1977). Estuarine conditions in eco-region 3 may sometimes extend 10-20 miles offshore during periods of high river output.

The boundary between eco-regions 3 and 4 divides an area in the northern Gulf directly affected by the Mississippi and Atchafalaya Rivers (eco-region 3) from an area that is less directly affected by these river systems (eco-region 4). Eco-region 4 has more extensive areas of coastal marsh habitat and fewer oyster reefs than eco-region 3. Offshore habitats in eco-region 4 include rocky reefs, which are very rare in eco-region 3. As a result some reef species that occur west of the Mississippi Delta (eco-region 4) are not found east of the Mississippi (eco-region 3) in the northern Gulf (Hoese and Moore 1977).

The boundary between eco-regions 4 and 5 represents the approximate boundary between the West Indian and Louisianan biogeographic provinces in the Western Gulf (Cowardin *et al*. 1979). The boundary separates an area with a greater temperate influence (eco-region 4) from an area with an increased subtropical influence (eco-region 5). Ecoregion 4 tends to have lower temperatures and higher rainfall, with accompanying lower salinities, than eco-region 5 (Hoese and Moore 1977). Eco-region 5 has much less marsh habitat compared with eco-region 4. Eco-region 5 has limited amounts of seagrass not found in eco-region 4, and the southern end of eco-region 5 contains some hypersaline habitats (Hoese and Moore 1977).

The divisions between these putative eco-regions were agreed by the project team as a reasonable means of sub-dividing the Gulf of Mexico into smaller areas of relatively uniform biological and physical characteristics. No formal analysis or survey was undertaken to verify the applicability of the scale and areas of these sub-divisions. However, they were considered to be adequate for operational use in the analysis of data for this EIS.

Using information on the general distributions of the life stages of Gulf of Mexico FMP species, a density status was allocated for each species/life stage in each eco-region. Terms used to describe density status were chosen to match up with the terminology used in the NOAA Atlas (see Section 2.1.3.3.1.3). Egg, larval, and postlarval stages were designated as either "no occurrence", "occurrence", or "common" in an eco-region, representing increasing levels of abundance. For juveniles, the status of the life stage in an eco-region was categorized as "no occurrence", "occurrence", or "nursery area". For both adults and spawning adults, the categories used were "no occurrence", "occurrence", "adult area", or "major adult area and commercial fishing ground". In addition to the information recorded in the database (based on the NOAA Fisheries tables in Appendix C), additional literature on ichthyofauna in the Gulf of Mexico was consulted to make judgments about the distribution status of species/life stages. Sources included Bohlke and Chaplin 1968, Hoese and Moore 1977, Fisher 1978, Robins *et al*. 1986, Humann 1994, Rydene and Kimmel 1995, and the FishBase database (www.fishbase.org). All of the final density designations by eco-region are provided in tables presented in Section 3.2.4.

If a species/life stage was recorded as present within an eco-region (i.e. density status greater than "no occurrence"), substrates and depths within that eco-region with documented use for feeding, growth to maturity, or spawning were designated as potential habitat. Eco-regions where the density status for a particular species/life stage was higher (according to the scale described above) were considered to have more suitable habitat, and therefore more likely to constitute EFH for that species/life stage.

One limitation of this analysis was that the habitat use database contains general information for habitat use in the Gulf, but not eco-region specific information on habitat use. If a species/life stage occurred in an eco-region, it was assumed to use all the habitats listed for it in the database. However, in some cases a specific eco-region might not contain all the habitats listed for the species/life stage on a Gulf-wide basis.

In cases where substrate and depth preferences, and/or geographic density status information was not available for certain life stages of managed species, information on other life stages of the same species, or the same life stage of a similar species was used as a proxy. For example, the anchor, blackline, and goldface tilefish have no habitat preference information recorded. The life history requirements of blueline tilefish were used as a proxy for these species, because they are all from the same life history guild. In a number of cases, the depth range of eggs, larvae, and postlarvae was inferred from the depth range of spawning adults of the same species (e.g. cubera snapper), because it was assumed that these life stages would occur in the vicinity of areas where they were spawned. In addition, missing information on juvenile stages of offshore species was sometimes inferred from information on adults of the same species, and missing spawning adult information (e.g. depth range) was sometimes inferred from adult information.

There are several habitat types recorded in the habitat use database that are not mapped in the GIS (see table at the end of Section 2.1.3.3.2.3). This may affect the way in which the information on functional relationships can be used to infer the locations of EFH. Essentially, if a habitat is not mapped in the first place, then it can not be mapped as EFH as required by the EFH Final Rule.

The categories banks/shoals and shelf edge/slope that are included in the habitat use database, are represented in the GIS as the actual substrate, or habitat of which they are composed i.e., if a bank or shoal is composed of sand, then in the GIS it is shown as sand. Its depth is also shown. Functional relationships for a species/life stage in the database in this instance would be recorded for both bank/shoal and for sand/shell bottoms. Hence the EFH for this species/life stage would be correctly represented even though banks and shoals are not mapped separately in the GIS.

For the pelagic or water column habitat, this exists wherever there is estuarine, near shore or offshore habitat. It is not explicitly mapped, except by reference to water depth and/or eco-regions. EFH for species/life stages that occur in the water column (i.e. non-benthic) is mapped either based on the distribution information in the NOAA Atlas or according to their preferred ranges as indicated in the habitat use database by depth and eco-region.

Drifting algae, which are part of the water column habitat are also not mapped explicitly due to their mobility. EFH for species/life stages that associate with floating algae such as sargassum is mapped based on their preferred ranges as indicated in the habitat use database by depth and eco-region. If drifting algae should move outside of this range, then it will be outside the area identified as EFH and will therefore not be part of EFH as mapped in the alternatives.

Regarding artificial structures (e.g. structures associated with oil and gas extraction, artificial reefs of varying size and construction), the Gulf Council has had considerable discussion regarding their status as potential EFH. Artificial structures can be considered to be analogous to hard bottom, although the extent to which this analogy holds true is unknown. In fact, these structures represent a large number of “pinpoints” spread over the geographic space of the whole Gulf, rather than distinct parcels of habitat that could be portrayed as habitat polygons on a map. To the extent that artificial structures are located within the area described and identified as EFH, any future action that is likely to affect the way in which they provide habitat to managed species will be subject to the EFH consultation process described at the beginning of Section 2. Artificial structures have not, however, been identified as a separate habitat type in the EFH analysis. Although there are maps available of the location of examples of artificial structures (see Section 3.2.2.7), they are not mapped in the GIS as potential EFH. Therefore if a structure is located outside the area otherwise identified as EFH then it will not be regarded as a component of EFH and actions that affect the way in which it provides habitat to managed species will not be subject to specific EFH consultation. However, such action would remain subject to the existing NOAA Fisheries consultation process (see Section 3.4.1.6.5), and other relevant Federal regulation.

2.1.3.4 Developing alternatives for EFH

EFH must be described and identified for each of the seven FMPs of the Gulf of Mexico: Red Drum, Reef Fish, Coastal Migratory Pelagics, Shrimp, Stone Crab, Spiny Lobster, and Coral. NEPA requires consideration of a broad range of alternatives for each of these FMPs. Although the FMPs cover quite different fisheries with different species and hence different habitat requirements, the principles on which EFH are identified in each are broadly similar. In order to take advantage of this similarity and to avoid unnecessary and cumbersome duplication of information under each FMP, we adopted a two-stage approach in developing EFH alternatives. We first identified several conceptual approaches to identifying EFH. Each concept describes the general basis for developing alternatives under each of the FMPs. The Council reviewed these concepts, and some were considered and rejected at the concept stage. This saved time in preparing the EIS. Had we chosen to fully develop and map specific alternatives under each FMP before the Council could discuss them, this would have taken substantially more time, and given that some of the concepts were rejected (see below), this time would have been wasted. Specific alternatives for each FMP are subsequently elaborated and mapped under each concept.

2.1.3.4.1 Concepts for describing and identifying EFH

The number of viable conceptual approaches was limited to a large extent by the available information. As described previously, information for some species and life stages exists at level 2, but virtually no information exists at levels 3 or 4 for managed species in the Gulf of Mexico. In all, eight concepts for describing and identifying EFH were developed. These are described in detail below.

2.1.3.4.1.1 Concept 1: No action

This concept covers the requirement under NEPA for a "no action" alternative. It would result in no EFH being described and identified under any of the Gulf FMPs. The No Action alternatives would roll back the Council's designation of EFH under the 1998 Generic Amendment. The existing status-quo designations (see Alternative 2 from the Generic Amendment) should not pre-suppose any changes to EFH designation the Councils may wish to take as a result of analysis in this EIS. Therefore, it is necessary to consider alternatives that do not result in any EFH designations. Under the No Action alternatives, no EFH can be mapped. However, the M-S Act requires each Council to describe and identify EFH for species under management by an FMP. Alternatives based on this concept would therefore not meet the requirements of the M-S Act.

The No Action alternative does not mean that no protection will occur for fish habitat in the Gulf of Mexico. The Gulf Council and NOAA Fisheries have already taken a variety of measures in management plan amendments that protect fish habitat from the effects of fishing. The effects of previous fishery management measures on fish habitat are summarized below and are described in more detail in Section 3.4.1.2.2.

In some cases, habitat protection has resulted from direct action intended to mitigate impacts on habitat. In other cases habitat protection has occurred as a collateral benefit of management measures with other purposes. The Gulf Council has established three Habitat Protection Advisory Panels (HAP) for advice on habitat-related issues, and protection of habitat has resulted directly from several management actions:

- Prohibitions on the use of explosives, chemicals, and anchoring in sensitive areas;
- Designations of marine protected areas (MPAs) for the purpose of habitat protection; and
- Restrictions on the use of some fishing gears.

Examples of specific protection of habitat includes the Gulf Council's prior designation of certain habitat areas for critical life stages of some species, such as the marine protected area (MPA) designation for Madison-Swanson and Steamboat Lumps, which are known spawning aggregation sites for gag, and the seasonal closure of Riley's Hump in the Tortugas (now encompassed by the larger Tortugas MPA), for mutton snapper spawning.

Indirect protection of habitat has resulted from management actions that required gear modifications, harvest limits, license and permit limitations, prohibitions of fishing activities, time/area restrictions, designation of MPAs (not for the purpose of habitat protection directly) and fishing gear restrictions.

Any future changes in management regimes that would effectively limit gear or fishing effort would also provide protection to habitat of one degree or another insofar as they reduce the direct interactions between gear and habitat. Additionally, many existing Federal and state laws and regulations already require evaluation of the consequences of projects proposed for the marine (and other) environments. NOAA Fisheries already has the ability to recommend, through consultations, mitigation or minimization of adverse impacts on those habitats that are important to fishery resources.

Thus, the Gulf Council and NOAA Fisheries could continue to address fishing and non-fishing impacts on fish habitat without designation of EFH through the types of mechanisms and actions described above.

2.1.3.4.1.2 Concept 2: Status quo

Under this concept, EFH is described and identified as in the Gulf of Mexico Council's Generic EFH Amendment (1998), which described it as those habitats coinciding with the known distributions of the adults of 26 selected species under management.

This concept is 'status quo' and would produce alternatives that are the same as the alternative described in the Gulf Council's Generic Amendment (GMFMC 1998). This was approved by NOAA Fisheries, but only for the species included in the analysis. Approval for other species in the management units was deferred pending the ability to describe EFH for those species. The 1998 Generic Amendment identifies and describes EFH as areas where the various life phases of 26 selected species and the coral complex commonly occur. This is based on Level 1 information, the presence/absence or distribution, for some species and life stages and on Level 2 information, density distribution, for other species and life stages.

Because of the diverse habitat requirements of multiple life stages of the 26 selected species and the other species under Federal management, EFH for these 26 species collectively occur in nearly all habitats of the Gulf of Mexico. This effectively includes all waters and substrates from the shoreline to the seaward limit of the EEZ, including the substrates mud, sand, shell, rock, and associated biological communities; coral habitats (coral reefs, coral hard bottoms, and octocoral reefs); sub-tidal vegetation (seagrass and algae); and adjacent intertidal vegetation (wetlands and mangroves). For example, just the reef fish species have been documented in estuarine, inshore, and offshore waters, on reefs, other hard bottom, soft bottom, vegetated areas, and floating vegetation at one life stage or another. Other species groups such as shrimp additionally occupy low salinity estuarine and nearshore areas of the northern Gulf of Mexico.

Many species under management by the Gulf Council are dependent on estuaries, and they spend at least part of their life cycle (usually the early phase) in estuarine habitats. The 1998 Generic EFH Amendment therefore separated EFH into estuarine and marine components for purposes of the amendment. For the *estuarine* component, EFH is all estuarine waters and substrates (mud, sand, shell, rock and associated biological communities); sub-tidal vegetation (seagrasses and algae); and adjacent inter-tidal vegetation (marshes and mangroves). In *marine* waters of the Gulf of Mexico, EFH is virtually all marine waters and substrates (mud, sand, shell, rock and associated biological communities) from the shoreline to the seaward limit of the EEZ.

The Generic Amendment did not include maps of the habitats designated as EFH, which is now required by NOAA Fisheries EFH regulations (the EFH Final Rule (50 CFR Part 600) – the "Final Rule"). Figures described in Section 3, which show the boundary of the US EEZ around the Gulf of Mexico, delineate the area designated as EFH under the Generic EFH Amendment.

2.1.3.4.1.3 Concept 3: List of specific habitat types

Under this concept, EFH is described and identified as all waters of the Gulf of Mexico within the known distribution range of managed species and their life stages that include submerged aquatic vegetation (SAV), mangroves, marshes, oyster beds, reefs, rocky coral reefs, octocoral reefs, hard/live bottoms, ledges, outcrops, *Sargassum*, and clay substrates. This specifies habitats that FMP species are generally known to use based on habitats commonly listed in the habitat-use database for managed species. The selected habitats are similar to the habitats that were listed in the 1998 Generic Amendment (Concept 2) and the overall distribution of EFH resulting from alternatives developed under this concept would not differ substantially from the status quo. Many Gulf of Mexico species have an affinity for particular habitats at different life stages and this list includes these known habitats. This alternative simplifies EFH designation and makes the designated habitats more apparent to stakeholders. However, this concept would not result in alternatives that fulfill the requirements of the M-S Act for any of the seven FMPs. The M-S Act limits the definition of EFH to habitats necessary for spawning, breeding, feeding and/or growth to maturity (functional requirements of managed species) and this concept does not link habitat use to these functional requirements.

Concept 3 was considered and rejected, therefore no alternatives were developed under this concept (see Section 2.6.1).

2.1.3.4.1.4 Concept 4: Known distributions of species in the FMUs.

Under this concept, EFH is described and identified as those habitats coinciding with the known distributions of all life stages of all species under management. EFH is designated on the basis of available empirical distribution data, plus information on the functional relationships between fish species and habitats, from which broad distributions can be inferred. The extent of EFH for each species and life stage would be defined by Level 1 information (distribution data). According to the Final Rule, distribution data may be derived from systematic presence/absence sampling and/or may include information on species and life stages collected opportunistically. In the event that distribution data are available only for portions of the geographic area occupied by a particular life stage of a species, habitat use can be inferred on the basis of distributions among habitats where the species has been found and on information about its habitat requirements and behavior. Habitat use may also be inferred, if appropriate, based on information on a similar species or another life stage. If only Level 1 information is available, distribution data should be evaluated (e.g., using a frequency of occurrence or other appropriate analysis) to identify EFH as those habitat areas most commonly used by the species.

This concept expands on the description of EFH in the 1998 Generic Amendment. Even though the 1998 Generic Amendment based its conclusions on only the adult stages of 26 representative species, it identified virtually all estuarine and marine waters of the Gulf of Mexico as EFH. This is due to the overlap of EFH of the selected species and their diverse habitat requirements. Therefore, it does not appear that this concept would identify EFH that was substantially different in area extent to the status quo concept. It would, however, specify pelagic habitat as a component of EFH and for the purposes of consultation it would provide a more accurate representation of the number of species and life stages likely to be affected by actions taken in different parts of EFH.

The GIS shapefiles from the NOAA Atlas, generated as described in Section 2.1.3.3.1, were used to delineate distribution polygons for the species and life stages of each FMP that exist in the atlas. All digitized distribution polygons from the NOAA Atlas were overlaid and the appropriate species and lifestages were selected by FMP to represent EFH. The selected distribution polygons were united into one seamless boundary for each FMP representing EFH under this concept for the species and lifestages within the NOAA Atlas. Species and lifestages not represented by the NOAA Atlas were accounted for by utilizing the results from the analysis of functional relationships, as described in Section 2.1.3.3.2. For this concept, all areas with a density status greater than "no-occurrence" (i.e. all areas where the species/life stages were considered to be present) were identified as EFH. The Functional Relationship distribution polygons were overlaid with the distribution from the NOAA Atlas and the polygons were united to create a seamless EFH boundary for each FMP. Each EFH boundary was clipped south of the EEZ along the Texas/Mexico boarder and south of the GOM/ATL Fisheries Management Council boundary along the Florida Keys.

2.1.3.4.1.5 Concept 5: Areas of higher species density, based on the NOAA Atlas only

Under Concept 5, EFH is described and identified as the areas for each FMU species and life stage with the highest relative densities, as shown in the NOAA Atlas. When Level 2 information is available, it should be used to identify EFH as the habitats supporting the highest relative abundance within the geographic range of a species. As noted in the EFH Final Rule (50 CFR Part 600), because the efficiency of sampling methods is often affected by habitat characteristics, strict quality assurance criteria should be used to ensure that density estimates are comparable among methods and habitats. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value. When assessing habitat value on the basis of fish densities in this manner, temporal changes in habitat availability and utilization should be considered.

As described in Section 2.1.3.3.1, the NOAA Atlas contains information on density for 21 species and life stages across six FMPs. Because this concept distinguishes areas of habitat with higher densities from the total range for an individual species and life stage, it is likely to result in less area being designated as EFH for individual species and life stage than alternatives developed under Concept 4. In addition, it does not identify EFH for species and life stages not included in the NOAA Atlas.

The GIS shapefiles from the NOAA Atlas, generated as described in Section 2.1.3.3.1, were used to delineate density polygons for the species and life stages of each FMP that exist in the atlas. All digitized density polygons from the NOAA Atlas were overlaid and the appropriate species and lifestages were selected by FMP to represent EFH under this concept for each FMP alternative. The density polygons were selected based upon the "Highest Density Category" shown in the table in Section 2.1.3.3.1.3. The selected density polygons were united into one seamless boundary for each FMP representing EFH under this concept for the species and lifestages within the NOAA Atlas. No information from the functional relationships analysis (Section 2.1.3.3.2) was used in this concept. Each EFH boundary was clipped south of the EEZ along the Texas/Mexico boarder and south of the GOM/ATL Fisheries Management Council boundary along the Florida Keys.

2.1.3.4.1.6 Concept 6: Areas of higher species density, based on the NOAA Atlas and functional relationships analysis

There are some species and life stages in the FMUs for which density data are not available in the NOAA Atlas. Concept 6 seeks to expand Concept 5 to as many species and life stages as possible in the FMUs by combining the density data that are available in the NOAA Atlas with density information derived from an analysis of functional relationships between fish and their habitats (see Section 2.1.3.3.2). This concept seeks to use the maximum amount of information currently available on fish distribution, while meeting the need expressed in the EFH Final Rule to distinguish between all habitats potentially occupied by species and their EFH.

For those species and life stages without density information depicted in the NOAA Atlas, there are no empirical distribution or density data currently available. However, information from the literature identifies the associations and functional relationships between species and life stages and their habitats. This information can also be used to infer, on an eco-region scale, relative differences in density of species and life stages from one region to another. Under this concept, the area identified as EFH for species and life stages with no density data in the NOAA Atlas is inferred by plotting the distributions of habitats with which they are known to associate at the highest level of known occurrence for each species/life stage (see Section 2.1.3.3.2). Implementation of this concept requires information on both habitat utilization and the location and extent of habitats.

2.1.3.4.1.7 Concept 7. Salinity range

Concept 7 describes and identifies essential fish habitat based on a range of salinity corresponding to the preferred range of species and life stages in each FMU. As described in Section 2.1.3.3.1, the Generic Amendment contains fish distribution information for selected species based on salinity-density information, prepared by NOS. However, neither the NOS distribution maps nor salinity isohalines were available in a GIS format at the time of preparation of the EIS. The NOS distribution maps were only available in small format, low quality images (letter size PDF) and therefore could not be scanned reliably into the GIS. Therefore no maps of preferred salinity ranges could be prepared for species and life stages in the FMUs of the Gulf Council's FMPs. Salinity preference information is available for only some Gulf FMP species. Additionally, isohaline lines are dynamic features, which change substantially with the tidal, lunar, and seasonal cycles, especially around the Mississippi River area. Therefore, the areas described and identified as EFH under this Concept would be in a constant state of flux. Even with a substantial spatial and temporal analysis of salinity variations it would be difficult to use salinity as a key factor in identifying EFH.

Concept 7 was considered and rejected, therefore no alternatives were developed under this concept (see Section 2.6.1).

2.1.3.4.1.8 Concept 8. Habitat suitability modeling (HSM)

National Ocean Service (NOS), scientists at the Florida Marine Research Institute, and others have been collaborating to develop modeling procedures to develop indices that spatially delineate the suitability of fish habitats for fish and invertebrates (Rubec *et al*. 1999). This modeling, known as Habitat Suitability Modeling or HSM, is being conducted to help determine optimal fish habitats to support decision making for management of EFH. It integrates distribution of habitats and environmental parameters with the species affinities for each (species abundance), using a geographic information system (GIS) to identify, which are most important in explaining species abundance (Rubec and McMichael 1996). This methodology is also being employed in the US Caribbean and west coast regions for use in future identification of EFH. Several limited efforts have been undertaken in the Gulf region to predict the distribution of certain species (Sheridan 1996; Rubec *et al.* 1998; Gallaway *et al*. 1999), but no such analyses are currently available for consideration for any species within the seven FMPs. Research underway may be extended in the future to include these species. Future updates of EFH by the Council may incorporate such analyses.

Concept 8 was considered and rejected, therefore no alternatives were developed under this concept (see Section 2.6.1).

2.1.3.4.1.9 Considered and rejected concepts

The Council reviewed these concepts at several meetings in 2002, and at their November 2002 meeting considered and rejected Concepts 3, 7, and 8 (see also Section 2.6 – considered and rejected alternatives). The Council agreed with specific recommendations from the Technical Advisory and User Panels that:

- Concept 3 provided only a list of habitats that, while important, did not use information on the ecological function provided by the habitats for managed species;
- Concept 7 used only salinity preferences for each species and life stage, did not relate habitat function to an area's potential designation, and salinity ranges are not static and shift over time; and
- application of the methodology described in Concept 8 in this region is too new for current consideration, but should be reconsidered when more information becomes available.

2.1.3.4.2 Applying the concepts to the FMPs

Each of the EFH concepts that the Council agreed to consider further was used to develop specific alternatives under each of the FMPs. These alternatives are presented in Section 2.3. The alternatives explain specifically how EFH is described and identified in each case. In addition, for each FMP, where possible, they present maps that show the composite EFH for all species and life stages under each FMP.

Mapping of the alternatives developed under Concepts 4, 5, and 6 for each FMP used GIS methodology to combine maps of species distribution, habitat distribution and information on species habitat utilization, which are both described in the preceding sections. Each map of EFH for the alternatives developed under Concept 4 is a composite of the EFH based on total distribution of the individual species and life stages within an FMP. These maps combine the empirical distribution from the NOAA Atlas and the distribution of habitats used by each species and life stage in the FMU of an FMP determined from the species/life stage/habitat-use database. Each map of EFH for the alternatives developed under Concept 5 is a composite of the EFH based on the highest density of individual species and life stages within an FMP, as shown in the NOAA Atlas. Each map of EFH for the alternatives developed under Concept 6 is a composite of the EFH of the individual species and life stages within an FMP based on density from the NOAA Atlas if available and density based on habitat use from the species/life stage/habitat-use database.

No alternatives were developed under Concepts 3, 7, and 8 because these were considered and rejected by the Council. Therefore no maps were drawn. No maps were drawn for the alternatives developed under Concept 1 because this concept does not describe and identify EFH. alternatives developed under Concept 2, the status quo alternatives, are from the 1998 Generic Amendment. The 1998 Generic Amendment did not provide maps of EFH, although they could be drawn based on the EFH descriptions. However, no new maps were drawn for alternatives under this Concept in this EIS.

2.1.4 Designating HAPCs

2.1.4.1 Introduction

The EFH regulations encourage regional Fishery Management Councils to designate habitat areas of particular concern (HAPC) within areas identified as EFH to focus conservation priorities on specific habitat areas that play a particularly important role in the life cycles of federally managed fish species. EFH potentially encompasses a very broad range of habitat used by managed species. The designation of EFH is focused on the habitat needs of individual species and life stages. EFH designation does not identify or attempt to add additional protection for areas of habitat within EFH that are most important to the survival and productivity of managed species, or particularly in need of protection for some other reason. EFH could be a very large component of the Gulf of Mexico ecosystem. However, identifying a few important habitat areas as HAPC on the basis of their habitat attributes encourages a higher level of scrutiny for conservation, and gives the managed species that occur there an extra buffer against adverse impacts. HAPCs were intended to be very specific, mappable, and definable areas; not broad areas of the Gulf or all areas of a particular habitat. HAPCs may be designated for purposes other than mitigating adverse fishing impacts. This is reasonable since there may be some habitats in an area stressed by non-fishing activities, but for which the threat from fishing activities is low.

The Council and NOAA Fisheries presently have the authority to manage fisheries and fishing gear within Federal waters and can, therefore, evaluate and restrict fishing gear as necessary on a case-by-case basis. Implementation of fishery-related restrictions applied to EFH and/or HAPC designated outside of Federal waters would require consultation and agreement with the relevant state agencies. Proposed alternatives for minimizing impacts of fishing on EFH are presented in Section 2.4. Identification of HAPCs also gives the Council and NOAA Fisheries added opportunity to influence non-fishing activities that may adversely affect habitat.

2.1.4.2 Habitat considerations for designating HAPC

Whereas EFH must be described and identified for each species and life stage in the FMUs, HAPCs are identified on the basis of habitat level considerations. The Final Rule lists the following considerations that should guide the designation of HAPCs (50 CFR 600.815 (a) (8)):

- The importance of the ecological function provided by the habitat;

- The extent to which the habitat is sensitive to human-induced environmental degradation;
- Whether and to what extent development activities are or will be stressing the habitat; and
- The rarity of the habitat type.

Musick (1999) proposed using three principles to determine important habitat areas: utilization, availability, and vulnerability. DeAlteris (2002) advanced this concept by recommending priorities for habitat conservation inversely related to availability (comparable to the concept of rarity in the above list) and directly related to utilization (comparable to ecological importance) and vulnerability (comparable to sensitivity and stress). DeAlteris quantified these principles in evaluating effects of mobile fishing gears for the NE United States in making recommendations for prioritizations of fish habitat.

The designation of HAPCs is intended to identify to anyone considering actions that might be potentially threatening to habitat those areas of EFH considered to be of the highest importance in the life cycles of managed species and most in need of protection. An HAPC is expected to be a localized area of EFH that is especially ecologically important, sensitive, stressed, or rare when compared to the rest of EFH.

2.1.4.2.1 Ecological importance

In the context of this EIS, the ***ecological importance*** of a habitat stems from the function that it provides to the managed fish species. However, the Final Rule is not explicit regarding the metrics that should be used for measuring ecological importance. Gulf of Mexico fish utilize many types of habitat. For example, most reef fish spawn in offshore waters of the Gulf of Mexico where they produce pelagic eggs, eggs may drift inshore where juveniles use estuarine, shallow water, or nearshore areas as nursery grounds, and move offshore as adults to live on demersal habitats. Other species spend the entire life cycle in open waters. In no case, does enough information exist to definitively determine levels of ecological importance for the managed fish species.

A variety of approaches could be used to measure or represent ecological importance, including:

- habitats that support the ecological activities of a larger number of managed species life stages;
- habitats that support important ecological functions of managed species (bottlenecks); and
- habitats that support species that play an important role in the food web (e.g. forage species)

An important aspect of measuring ecological importance for the purpose of identifying HAPCs is that the metric used provides sufficient contrast to enable local areas to be distinguished from one another. Preferably, this is done quantitatively rather than qualitatively. The first approach listed above (habitats that support the ecological activities of a larger number of managed species' life stages) readily lends itself to quantification, and the necessary information is available in the habitat use database described in Section 2.1.3.3. The rationale for this approach is that greater number and variety of species and life stages that rely on the habitat for completing their lifecycle, the more ecologically important that habitat is likely to be and the greater the ecological benefit that is likely to be derived from protecting it (and conversely the greater the ecological cost of adversely affecting it).

The habitat use database contains information on the specific ecological functions being performed by managed species in specific habitats (spawning, breeding, feeding growth to maturity). Some of this information was derived from the habitat use tables presented in Appendix C. Making reasonable assumptions about the possible activities of each life history stage augmented this information. Note that the term "breeding" was considered to refer to live bearing of young. None of the managed species in the Gulf of Mexico exhibit this life history strategy, therefore this ecological function is not included in the database. Each life history stage can use the habitats on which it is found for one or more of the three remaining ecological functions. Of the three possible functions, eggs can only perform "growth to maturity." Larvae, postlarvae, early juveniles, and late juveniles can perform "growth to maturity" and also possibly "feeding." Adults, by definition, are already mature, and so can only perform "feeding." Finally, spawning adults can perform "spawning" and also possibly "feeding" (although this is rarely documented). For stages less developed than adults, if there was no other documented function, then they were recorded as using the habitat for "growth to maturity." For spawning adults, if there was no other documented function, then the function was listed as "spawning."

Separate queries were run for the suite of species in each FMP (excluding the Coral FMP). Each query produced tables providing a tally of the number of species/life stages that use each habitat for each of the three ecological functions in each eco-region. Habitat use information was not available on the scale of eco-regions. Therefore the habitats occupied by a species/life stage and the functions performed in those habitats were the same for all eco-regions in which the species/life stage was considered to occur (providing the habitat itself occurred in the eco-region).

The tally results or scores were used to rank habitats in order of importance for each FMP and ecological function within each eco-region. Rankings were structured from highest to lowest, the higher the score, the higher the overall ecological importance. Habitats with the same score were given equal ranking. Habitats with a score of zero for an FMP/ecological function/eco-region combination (i.e. there were no species/life stages within that FMP performing that specific function) were given a rank of zero.

Each of these rankings could be used alone (e.g. to indicate the habitats most used for a particular function by species in an FMP) or they could be combined for an FMP to indicate the habitats having higher use score across all functions. To combine the rankings within FMPs, each habitat has its three scores (for growth, feeding, spawning) averaged. Habitats within FMPs and eco-regions were then re-ranked according to these average scores. The results of these analyses are presented in Section 3.2.4. Maps depicting the habitat use rankings of mapped habitat types are also provided. These maps are used to show locations of potential HAPCs for the purposes of developing HAPC alternatives under each FMP. Note that a separate ranking was not calculated for the Coral FMP. The ecological importance of coral as a habitat for managed species is shown by the results for the other six FMPs. The ecological importance of coral as a habitat for coral was considered to be self-evident. No means of distinguishing between the importance of one piece of coral habitat over another in this context was devised, or considered to be necessary.

In addition to the rankings under each FMP, a composite ranking of overall use of habitat across all FMPs was also developed. This was intended to show areas of habitat that are important for all FMPs to provide additional options for identifying HAPCs. In an early draft of the EIS the habitat use ranking had been developed without reference to individual FMPs. Rankings were based on the use of habitat by all managed species. However, in reviewing the results of this analysis, the Council determined that it gave undue weight to habitats used by reef fish, due to the large number of species under this FMP compared to the others. There is also the problem that the species range in some FMPs cover more habitats than others. The revised analysis presented below attempts to create a composite ranking that gives equal weighting to all FMPs.

The individual FMP habitat use ranks were converted to a score that is the reverse order of the rank to give a higher number for a higher use rank. For example, the number 1 ranked of 14 habitats would receive a score of 14, and the lowest ranked (14th ranked) would receive a score of 1. Ties received the same score. For example, three habitats tied for a rank of 2 would all receive a score of 13, and the next highest habitat (rank of 5) would receive a score of 10. Habitats unused by species in an FMP received a score of 0.

Summing these raw scores across FMPs would bias the composite rank because of the unequal number of habitats occupied by species in the FMPs. For example, species in the reef fish FMP occupy a total of 26 habitats, while species in the Pelagics FMP occupy only 9 habitats in total. The ecologically most important Reef Fish habitat would have a score of 26, while the ecologically most important Pelagics habitat would have a score of only 9.

The habitat scores for each FMP were therefore normalized by dividing the score of each habitat in an FMP by the highest score for a habitat in that FMP. Thus, the normalized score of the highest scoring Reef Fish habitat (26/26) and the ecologically most important Pelagics habitat (9/9) both equal 1. Summing the normalized scores across all FMPs gives a composite score. These normalized scores were then ranked from highest to lowest (Section 3.2.6).

The results of this composite ranking analysis are also presented in 3.2.6

This analysis could be expanded using weighting factors to add greater importance to factors such as those in the second and third bullets in the list above. For example, increased weight could be given to habitats that fulfill a larger number and variety of ecological functions for individual species, which might therefore represent bottlenecks. Similarly, the life stages of keystone prey species could be given additional weighting (rather than simply counting each as 1). Neither of these possible expansions was attempted during this study.

2.1.4.2.2 Sensitivity to human-induced environmental degradation

Human induced environmental degradation can result from both fishing activities and non-fishing activities such as coastal development and pollution. Certain habitat structures such as reefs, hard/live bottom, mangroves, seagrasses, and marshes are particularly sensitive to human-induced environmental degradation. They are sensitive to fishing gears and other activities such as dredging, mining, pipeline construction, coastal development, shipping, contaminants, and disposal.

In developing metrics for sensitivity, we have considered the inherent susceptibility of habitats to fishing and non-fishing impacts that are likely to result in impairment of the function of the habitat for fish species. This does not mean these impacts and the impairment have occurred, are occurring or will necessarily occur in the future. It is merely a measure of the potential for impairment given the types of activities that could affect the habitat, and the natural characteristics and situation of the habitats themselves.

The methods used to develop indices of habitat sensitivity are described in this section. The types and extent of fishing and non-fishing impacts on habitat are presented in detail in Section 3.5.

An evaluation of fishing impacts is important both in the identification of potential sites of HAPC, EFH Final Rule (600.815(a)(2)), and to provide guidance on the types of impacts that need to be prevented, mitigated, or minimized under the requirements of the M-S Act. In addition to providing a metric for identifying HAPCs, the evaluation of non-fishing impacts contributes to the evaluation of the likely benefits of possible modifications to fishing activity by providing information about cumulative impacts. Bearing in mind that only reasonably foreseeable changes to non-fishing activities can be considered in this EIS, an evaluation of non-fishing impacts is important in evaluating the practicability of the fishing impacts alternatives (Section 2.1.6.4).

2.1.4.2.2.1 Sensitivity of habitats to fishing impacts

Different fishing gears affect habitats to different degrees. Mobile gears, such as bottom trawls and dredges, have a potential to affect habitat over a wide area, because the gear is in direct contact with and moves across the substrate and any biogenic structures. Non-mobile gears fish primarily in a fixed location, so their direct effects on habitat are generally confined to that location or "footprint." The damage from a single encounter in either case can range from negligible to severe. However, the adverse effects on EFH of fishing that are to be prevented, mitigated, or minimized relate to the functional relationship between habitat and fish. At this time, only limited information exists to relate fishing activities to habitat damage (Rester 2000, Hamilton 2000, Barnette 2001, Johnson 2002, NRC 2002), and there is no basis yet for a quantitative link between habitat damage and habitat function. Therefore only a speculative, qualitative evaluation of the degree of impairment of the function of the habitat for fish species and life stages that results from these impacts can be made. Nevertheless, attempts have been made to combine these concepts – the likely degree of damage from a single encounter, and the resulting impaired function for fish – to create a scale of potential habitat damage that we have called the ***fishing gear sensitivity***:

- High (3 or +++): Capable of severe damage to a wide swath of habitat during a single encounter. Seriously impairs the function (for fish) of the impacted habitat.

- Moderate (2 or ++): Capable of severe damage to habitat in a "footprint" of the gear during a single encounter; or capable of moderate damage to habitat over a swath. Impairs the function (for fish) of the habitat.

- Minor (1 or +): Capable of moderate damage to habitat in a limited area during a single encounter. May impair the function (for fish) of the habitat.

- Negligible (0): Does not typically cause damage. No perceptible impairment to the function (for fish) of the habitat.

Damage in the high category would involve widespread and severe damage from a single encounter that seriously impairs the ecological function of that habitat for managed fish species, while 'negligible' indicates no appreciable impairment to the ecological function of the habitat. The analysis of fishing sensitivity involved an evaluation and weighting of each of the fishing impact types for a given habitat type, based on best scientific judgment and literature reports.

A fishing gear sensitivity score is allocated to each potential combination of habitat type and fishing gear. These relative measures are primarily taken from rankings developed during a 1999 NOAA Fisheries workshop on gear impacts on essential fish habitat in the NOAA Fisheries Southeast Region (Hamilton 2000, Barnette 2001) and additional discussions of gear and habitat by Barnette. The NOAA Fisheries habitat-gear ranking did not include all the habitats or gears analyzed for the Gulf of Mexico. Members of the Council's EIS advisory panels provided recommendations that assisted in ranking habitat-gear combinations not included in the NOAA Fisheries habitat-gear rankings.

The NOAA Fisheries workshop report did not include sensitivity rankings for the following habitats: mangroves, drift algae, emergent marshes, and coral reefs. Limited assessment was done for oyster reefs and pelagic habitats. Other than coral, oyster reef, and drift algae, these habitats are largely unaffected by fishing gears. This is either because the interaction is essentially benign, as in the pelagic habitat, or because gears cannot physically be used in the habitat, such as mangroves and emergent marshes. The sensitivity of coral was considered to be similar to hard bottom, but with more fragile structure and higher sensitivity to some gears. Drift algae can be picked up in pelagic nets, so some habitat sensitivity was considered in this interaction.

The workshop report also did not include the following gears in their analysis: roller frame trawl, pair trawl, crab scrape, tongs, or drop net. Barnette (2001) described available information on habitat impacts for crab scrape, tong, and barrier net, and this information formed the basis for sensitivity values on various habitats. Where information existed for similar gears, the fishing gear sensitivity was assigned by analogy. The roller frame trawl was considered as intermediate in score to roller trawls and frame trawl. The pair trawl was considered comparable to a shrimp otter trawl, but without doors. Drop nets (Section 3.5.2.1.13) are set flat on the bottom, and catch fish (mainly crabs) by lifting; this gear may have a minor impact on coral. Channel nets (Section 3.5.2.1.13) are a static gear that are attached to a structure in the water such as a dock or piling when a current is running, and they do not usually contact the bottom. Channel nets may capture drifting algae while fishing, which could cause a minor impact. The sensitivity score for oyster and clam gears and mobile gears, except skimmer trawls, were increased from a score of 2 to a score of 3 for coral, because of the more fragile nature of coral than most hard bottom organisms. The lighter construction of the skimmer and attachment of the net to vessels would cause relatively less damage to coral than other mobile gears. Rakes used on oyster reefs were assessed a sensitivity score of 2 rather than the score of 3 found in Barnette (2001), because it was felt that they do not typically do as much habitat damage as other level 3 gear/habitat combinations.

The Council's EIS User Panel also recommended reducing the NOAA Fisheries habitat-gear ranking for shrimp otter trawls on sand/shell habitat from a score of 2 to a score of 1. This change is supported by recent experimental work regarding the effects of shrimp trawling on sand/shell habitats (Sheridan and Doerr, in press). Shrimp trawls are smaller and lighter than fish otter trawls, and typically have lighter contact with the bottom. Sand generally occurs in higher energy environments than other sediments, so undergoes regular disturbance and therefore is likely to recover more quickly from impacts.

Sensitivity to human induced degradation is one of the considerations for HAPC (Section 2.1.4.2). Several habitats have sensitivity to many gears, while other habitats have little or no sensitivity. Some gears with sensitivity rankings for habitats are not used or used to a limited degree on these habitats. Gear use is described later under Fishing Effort (Section 2.1.5.2). However, the fishing sensitivity recognizes the potential for adverse impact that gears could cause. Summing sensitivity scores across gears developed an aggregate sensitivity score for each habitat. The habitats with the highest scores (See Section 3.5.2.2) have the highest aggregate fishing sensitivity, and therefore are given a higher consideration for HAPC designation.

The results of these analyses are discussed in Section 3.5.2.2.

2.1.4.2.2.2 Sensitivity of habitats to non-fishing impacts

A number of non-fishing impacts to EFH occur throughout the Gulf of Mexico region. These impacts include a variety of physical, water quality, and biological effects that vary throughout the Gulf of Mexico and are described in Section 3.5.3. The majority of these impacts are directly related to anthropogenic activities, the relative measure of which are an important factor in determining all of the potential impacts on EFH. An analysis of non-fishing effects and the relative intensity for each statistical zone within the GOM was performed using the methods described in this section and in Section 2.1.4.2.3. The offshore areas of the GOM were not included in this evaluation due to the paucity of relevant spatial data for anthropogenic effects.

The analysis of non-fishing impacts was conducted using a three-staged approach:

- evaluate sensitivity of each habitat type to each potentially impacting non-fishing activity;
- develop quantitative and spatial measures of non-fishing impacts; and
- estimate the habitat stress from non-fishing impact on the finest spatial scale possible.

The methods used for the first of these steps are described below. The methods used for the remaining two steps are described in the following section. The results of this analysis, in addition to providing metrics for identification of HAPCs under the non-fishing sensitivity and habitat stress considerations, are part of the assessment of non-fishing impacts for the analysis of cumulative impacts and practicability of the fishing impacts alternatives.

The analysis used to develop these sensitivity indices follows similar approaches recently used in habitat and ecological stressor evaluations in the Tampa Bay area and elsewhere (Hession *et al*., 1996; Jackson *et al*., 2000; Kurz *et al*., 2001; Kurz *et al*., 2002). The evaluation essentially is based on best scientific judgment and literature reports.

This sensitivity index was developed as a tabular matrix similar to that for fishing sensitivity. Sensitivity indices were scored based on the potential severity of a given activity/effect on a specific habitat. These scores ranged from 0 (no effect) to 3 (large effect). In several cases, best scientific judgment was used to develop a score for a given effect on a habitat. In other cases, scientific and resource management literature were reviewed to provide guidance on scoring non-fishing effects. Comprehensive management plans for the various National Estuary Programs were typically the best source of information for assessing the scores for each effect (e.g. Barataria-Terrebonne National Estuary Program, Galveston Bay National Estuary Program, 1994; Sarasota Bay National Estuary Program; 1995; Tampa Bay National Estuary Program, 1997).

Sensitivity index scores were assigned based upon the effect's direct influence on a specific habitat type; secondary effects were not considered since the range of effects were believed to be sufficient to address any potential secondary effects. Data from the sensitivity indices were mapped on a grid consisting of the 21 NOAA Fisheries Statistical Zones with bathymetry. Sediment and habitat types were assigned their respective relative sensitivity index values and mapped throughout the Gulf of Mexico. The results of this analysis are presented in Section 3.5.4.

2.1.4.2.3 Stress from development activities

Assessing the extent to which development activities are stressing or will stress areas of habitat requires knowledge of the spatial distribution of those activities in the past, present and possible future in relation to local habitats. To obtain a measure of the risk that an area is or will be stressed by development activities, data on the spatial intensity of these non-fishing activities must be combined with the sensitivity of habitats to impacts that they might cause (Section 2.1.4.2.2.2). For the purposes of this component of the EIS, "development activities" were considered to include all human induced non-fishing activities that might lead to impacts on EFH.

The consideration of stress of habitat areas from development activities in identifying HAPCs offers two possible interpretations. First, identify as HAPC areas that are stressed likely to become stressed. This approach is based on the concept of rehabilitation of areas for which recovery is possible. Secondly, identify areas free of stress as HAPC. This approach is based on the concept of protecting pristine areas through an increased conservation focus on the area. The interpretation used in this EIS is that the intention of the stress consideration for HAPC in the EFH Final Rule is to identify areas that are more stressed or in danger of becoming more stressed. The expectation is that areas that are pristine and are ecologically important for managed species will be identified through one or more of the other three considerations.

2.1.4.2.3.1 Distribution of development activities

To quantify the effects of non-fishing activities, GIS data that represented these activities were gathered from various sources throughout the Gulf of Mexico region and used in this analysis. These sources included the USGS, NOAA, USACOE, MMS, EPA, and various local government agencies. Every effort was made to select relevant, spatially accurate databases that had a continuous coverage throughout the Gulf of Mexico region. Most USGS data were terrestrial and continental U.S. wide. MMS data were typically Gulf wide and mostly submerged. NOAA data were mostly coastal Gulf, some only for Florida, and a few U.S.-wide. USACOE data were for coastal Florida. EPA data were for the terrestrial southeast U.S. Although not all of the individual types of non-fishing impacts could be evaluated and quantified due to the lack of data, those effects that were most representative and mappable were selected for this analysis. Some important categories of non-fishing activity that potentially impact EFH, such as wetland fill, were not available in mapped form and were therefore not part of the analysis. This analysis therefore likely represents the minimum impacts to EFH from non-fishing activities.

A detailed list of databases and their sources is presented in Appendix I (pages I-21 through I-43). This table provides information on the source agency, geographic coverage, database name, description, date, and contact information for each database used in the project. The final list of data used in the analysis included the following:

- Dredge and fill (area in acres and numbers of fill points) - number of acres of dredge and fill within each statistical zone from the following data: fairways, beach renourishment. Point values were created from the following data: aids to navigation, oil/gas structures, and marine facilities. These data were indicators of dredging since this would typically occur to facilitate passage of vessels in intercoastal waterways and access to marinas.
- Shoreline hardening (length in miles) - number of miles of shoreline modification values created from the following data: Environmental Sensitivity Index Shoreline.
- Impingement/entrainment/thermal impacts (point) - number of impingement and thermal points within each Statistical Zone, values created from the following data: Steam Electric and Power Plant database (EPA). These facilities typically require large volumes of (marine) water for cooling power generation machinery and discharge to coastal areas.

- Structural Shading (points) - structural shading point values created form the following data: Marine Facilities (docks/piers) and Oil/Gas Structures (platforms).
- Boating Impacts (points and area in acres) - number of boating activity points values created from the following data: Marine Facilities. Number of acres of boating activity values created from the following data: Seagrass Scarring (FMRI), Fairways (USACOE).
- Altered Freshwater Inflow (points) – number of dams within a statistical zone – these data were acquired from NOAA maps.
- Point Source Pollution (points) – number of pollution points created from national pollution points maps (EPA).
- Non-Point Source Pollution (area in acres) – based on the total area of urban and agricultural land use (from USGS) within the contributing watersheds for a given statistical zone.
- Oil/Gas Operations (points, lines) – number of oil and gas operations and number of miles of oil and gas pipelines recorded within a statistical zone created from MMS database.
- Industrial Spills (points) – number of reported industrial spills from EPA databases.
- Toxic release (points) - number of toxic release points within each statistical zone created from EPA databases.
- Hypoxia (area in acres) – zones of low oxygen conditions in the northern Gulf of Mexico. These data were acquired from LSU maps.
- Harmful Algal Blooms (points) – these data were acquired from harmful algal bloom databases.

These data were then analyzed separately (clipped) for each of the 21 fishing zones throughout the Gulf of Mexico and further separated by a depth zone (estuarine versus nearshore). The estuarine zone was considered to be all areas inside barrier islands, or in the absence of barrier islands, inside the mouth of defined bays and lagoons. The nearshore zone encompassed the area between the estuarine zone out to the 10-fathom depth contour. These data are presented in Appendix H. Since the data varied by units (some data were points, others were in miles or acres), the values for a given activity/effect were reduced to a value based on a quartile distribution (0 = no effect, 1-25% = some, 26-50% = moderate, 51-100% = large) of those data throughout the region. For example, the range of values for Point Sources was from 0 to 254. A quartile distribution of this data would be broken down as follows: values greater than 0 and less than 64 were assigned a 1, between 65 and 129 a 2, between 130 and 194 a 3, and between 195 and 254 a 4. These values were then tabulated in the same format as the habitat/effect matrix (presented in Appendix H).

In the case of the Florida Keys, additional information was reviewed and incorporated in the measured effects analysis for statistical grid unit 1. Boating impact values were increased after reviewing seagrass propeller scarring information from the Florida Marine Research Institute. Point source impact values were increased after reviewing the Florida Department of Environmental Protection database for wastewater treatment plants, which showed a greater number of plants than were depicted using a national database created by the EPA. In addition, the nearshore effects were given the same scores as the estuarine effects since the boundary between these zones often overlap or are indistinguishable in this area.

2.1.4.2.3.2 Risk of habitat stress from development activities

The third tier of the analysis was to develop the measure of stress. Risk of habitat stress depends on the sensitivity of the habitat to non-fishing (development) activities, and the intensity of those activities on a local scale. For each habitat type, habitat zone and non-fishing impact type:

$$\textit{risk of habitat stress} = \textit{Sensitivity to non-fishing impact} \times \textit{Intensity of non-fishing activity}$$

These data were condensed by summing the total effects values for each habitat type by zone and plotting them on maps to show the relative distribution of scores throughout the Gulf of Mexico. These data represent the relative non-fishing effects values for each zone and depth (estuarine and marine). The results of this analysis are discussed in Section 3.5.4.

2.1.4.2.4 Habitat rarity

Musick (1999) recommended considering the availability of habitat in evaluating the need for habitat protection. Similarly, DeAlteris (2002) recommended an inverse relationship between availability (equivalent to a direct relationship with rarity) and habitat protection. If a habitat is ecologically important, and it is also rare, then the benefit of protecting it from adverse impacts is greater than if it is more common. A unit loss of more rare habitat will likely cause a higher loss in production for the species using that habitat, than for more common habitat, where species have the opportunity to utilize other areas with similar habitat characteristics.

Calculation of habitat rarity requires subdivision of the total area into parcels of contiguous patches of a single habitat type, characterized, for example, by substrate/biogenic structure type (see Section 2.1.3.3), depth, temperature and possibly some geographic range such as a pre-defined ecological sub-region. Ideally, the parcels should be of the same sort of local scale as that envisioned in the EFH Final Rule, so that the analysis can be used to identify viable candidate areas for HAPCs.

The ***rarity*** of a habitat parcel is measured in terms of the mapped area of the habitat type relative to the total area of all mapped habitat types multiplied by the distance to the nearest neighboring parcel(s). Calculations of this type can be implemented relatively easily in a GIS that maps out all the habitats. For this analysis a habitat rarity index was calculated as follows:

$$\textit{Rarity Index Score for habitat type within Unit} = \frac{\textit{Total Area of Unit}}{\textit{Total area of habitat type Within the Unit}} \times \textit{Average of the nearest neighbor distance for the parcels of habitat type within the Unit}$$

A habitat type was defined by its standard substrate/biogenic structure type (as mapped) and its depth (split into estuarine, and nearshore/offshore[3], as described in Section 2.1.3.3.2). A Unit is the same as an eco-region (see Section 2.1.3.3.2). The analysis was done separately for each eco-region in an effort to represent rarity on a reasonable scale. It gives scores on a scale from high rarity (high numbers) to low rarity (low numbers). For example:

A habitat type with total area of 5 in a Unit of total area 200, with a nearest neighbor distance of 20 would have a rarity index score of 800 ((200/5) x 20 = 800). Another habitat type with total area of 100 (20 times the first habitat type) in the same Unit (total area 200), with a nearest neighbor distance of 5 (one quarter of the first habitat type) would have a rarity index score of 10 ((200/100) x 5 = 10). The first habitat type would therefore be considered to be rare, and the latter would be much less rare (common).

The results of the analysis are described and discussed in Section 3.2.3.2.

2.1.4.3 Developing alternatives for HAPC

HAPC, by its definition in the EFH Final Rule, is a sub-set of EFH. HAPCs can therefore only be designated within the area described and identified as EFH under each FMP. Although some of the considerations for identifying candidate areas for HAPCs work across FMPs (e.g. habitat rarity), HAPC candidate areas should nevertheless be linked to the FMP under which they would most appropriately be designated. Accordingly, we have indicated, where possible and appropriate, which FMP specific HAPCs would be designated under.

2.1.4.3.1 Concepts and resulting alternatives for designating HAPC

Seven concepts were originally considered for designating HAPCs. Those applied to actual alternatives are described individually in more detail in Section 2.4 (alternatives) and Section 2.6 (considered but rejected alternatives). In summary, they were as follows:

- Concept 1. No action (roll back)
- Concept 2. Status quo
- Concept 3. Sites of special interest
- Concept 4. Spawning sites
- Concept 5. Nursery grounds
- Concept 6. Migratory routes
- Concept 7. Ecological bottlenecks

[3] The rarity analysis was initially performed for three units within each eco-region i.e. estuarine, nearshore and offshore separately. However, some misleading values resulted from unnatural breaks of habitat polygons between the nearshore, and offshore designations (at the 60ft isobath). To eliminate these results, the analysis was altered to combine the nearshore and offshore environments within each eco-region. Therefore, the analysis calculated rarity for two subunits instead of three. This alteration minimized the effects of unnatural breaks of habitat polygons.

As with EFH, a no action alternative is required under NEPA. The Council has previously taken action to designate HAPCs. The Gulf Council designated the Flower Garden Banks and the Florida Middle Grounds as HAPCs under the Coral FMP (August 1984) prior to the 1998 Generic Amendment, however, these are not currently HAPCs under the EFH provisions. If this alternative were chosen, there would be no designation of HAPCs under the EFH provisions.

In the 1998 Generic Amendment, the Gulf Council identified three general types of HAPCs and several specific HAPCs based on the four considerations described in the EFH Final Rule. These are described in detail in Section 2.4.2. The status quo alternative would leave this HAPC intact, but designate no others.

Alternative 3 would designate existing Federally designated marine and estuarine managed areas (e.g. MPAs, Federal wildlife refuges and sanctuaries, etc.). These are described in detail in Section 2.4.3. Note that some of these managed areas include terrestrial components. The landward boundary of any HAPC designated within a Federally managed area under Alternative 3 would be the same landward boundary of EFH.

Alternatives 4, 5 and 6 were all considered to represent various aspects of ecological importance; specifically sites important for spawning and growth to maturity. There is some information that has been used in the past to protect specific sites based on their importance for specific ecological functions. For example, the MPAs Madison-Swanson and Steamboat Lumps established by the Council encompass spawning areas for gag. The Council also established a seasonal closure of the mutton snapper spawning ground on Riley's Hump in the Dry Tortugas (this subsequently became an MPA).

However, the Council decided to "consider but reject" Alternatives 5 and 6 that focused on nursery grounds and migratory routes, respectively. Alternative 4 (spawning sites) was kept under consideration and refocused on reef fish species due to the importance and relatively limited aerial extent of known reef fish spawning sites. Additionally, a new alternative that specifically uses a decision analysis based on all the considerations in the EFH Final Rule to identify HAPC sites (i.e. not just ecological importance) was developed. This new alternative became Alternative 8 (see below).

Alternative 7 seeks to identify areas that may be obligatory for certain critical life history functions. For example, a fish species may spawn only on a special type of habitat in a limited geographic area and/or under specific physical conditions, such as temperature, tide, etc. A nursery area may consist of a particular type of vegetation or bottom type, or fish feeding may occur on other species that have specific habitat requirements. Such areas would automatically qualify for HAPC status under the consideration of ecological importance. They might also qualify under the rarity condition.

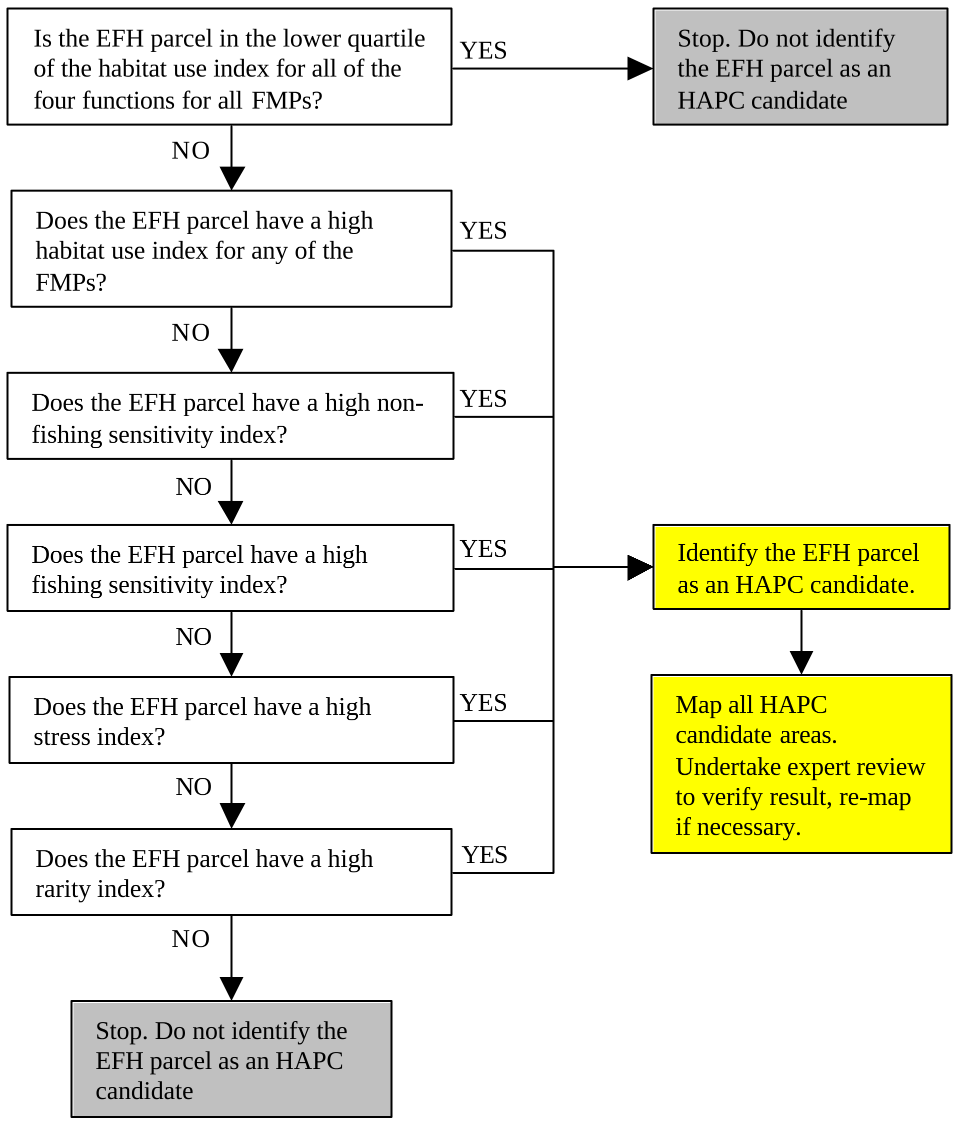
With respect to methods for identifying areas of habitat that might be bottlenecks to production, consideration was given to using the metrics of habitat use and habitat rarity to develop an index (termed "habitat utility") that could show where bottlenecks might be expected to occur. The rationale for this was that locations of habitats that are used by many species and are also rare are likely to be good candidates. It was agreed, however, that this index would likely be too imprecise and potentially misleading to use at this stage as an objective means of identifying HAPCs. It was also agreed that information at the species and life stage level would need to be considered, rather than using information across many species, such as is used in the habitat use index. With no objective means of identifying actual locations of ecological bottlenecks currently available, the project team concluded that they could only be identified on the basis of expert opinion. Section 3 provides the best available information on uses of habitat by species at different life stages. However, this information is generally insufficient to determine if associations with habitat are obligatory.

Alternative 8 was developed as a means of identifying HAPCs on the basis of all of the considerations described in the EFH Final Rule. These considerations are listed in Section 2.1.4.2 along with detailed descriptions of ways to make these considerations operational. Each of the methods described in Section 2.1.4.2 results in the production of habitat-based metrics that can be mapped to show the locations of HAPC candidate areas. The analysis of habitat use produced one map of the Gulf of Mexico for each FMP (other than the Coral FMP), and another for all FMPs. The analysis of sensitivity to human-induced environmental degradation produced two maps of the Gulf of Mexico; one for sensitivity to fishing impacts and one for sensitivity to non-fishing impacts[4]. The analysis of stress produced one map depicting the level of stress from development activities (i.e. non-fishing activities) across the Gulf of Mexico, based on the sensitivity of habitats and the intensity of non-fishing impacts. Finally, the analysis of habitat rarity produced one map. Each of these maps was scrutinized for areas that meet the conditions described in the Final Rule for identifying HAPCs under each of the four considerations.

The process of identifying HAPCs on the basis of the four considerations is illustrated in the decision tree in the following text box. According to the decision tree, candidate areas must, in addition to meeting the “high” thresholds for each of the four considerations, meet a minimum threshold for ecological importance (the habitat use index must be above the lowest quartile). The rationale for this is that if an area is not above this level of importance for the managed species from an ecological standpoint under one or more of the FMPs then it should not be identified as an HAPC under any of the FMPs. In practice, any area identified as a potential HAPC that does not meet this threshold would probably not be within any of the areas identified as EFH in any case. However, this will not be known until decisions have been made on the EFH alternatives.

[4] Note that these maps depict sensitivity only. They do not depict actual impacts, or probability of impacts because they do not include information on fishing effort and the intensity of non-fishing activities that impact habitat.

Gulf of Mexico Decision Tree for Identifying HAPC



The EFH Final Rule states that HAPCs are localized areas that are especially vulnerable or ecologically important. The decision tree refers to "EFH parcels" which are parcels or polygons identified in the GIS with particular levels for each of the indices linked to the four considerations. The scale of these parcels, and hence the scale of the areas that can be identified as HAPC is, however, limited by the analysis and the availability of information. The scale available under each of the considerations is described in the following text table.

Consideration for HAPC identification	Scale of EFH Parcel
The importance of the ecological function provided by the habitat	Habitat use was measured by habitat type, habitat zone (estuarine, nearshore, offshore) and eco-region
The extent to which the habitat is sensitive to human-induced environmental degradation	Habitat sensitivity was measured by habitat type
Whether and to what extent development activities are or will be stressing the habitat	Habitat stress was measured by habitat type, habitat zone (estuarine and near shore) and the 21 NOAA Fisheries statistical grid units.
The rarity of the habitat type	Habitat rarity, habitat type, habitat zone (estuarine, nearshore, offshore) and eco-region

The extent to which the areas that can be identified in this analysis can be considered to be "localized" is discussed as part of the rationale for Alternative 8 in Section 2.4.5.

2.1.4.3.2 Mapping HAPC alternatives

All mapping of the HAPC alternatives was conducted using a GIS developed exclusively for this EIS.

Alternative 1 requires no maps, because no HAPC are designated under this alternative.

Alternative 2 simply maintains the designation of HAPC as made under the 1998 Generic Amendment, but there were no maps of HAPC produced in that document. No maps of Alternative 2 were created for this EIS.

Alternative 3 utilizes existing boundaries from National Wildlife Refuges (NWR), National Estuarine Research Reserves (NERRS), NOAA Fisheries, and the National Park System (NPS). NOS provided these boundaries as GIS shapefiles (NOAA 2003c).

Alternative 4 would identify establish HAPC as those habitat areas used for spawning aggregations of managed reef fish species that are most in need of protection. Potential examples were identified in the Gulf Council's "Regulatory Amendment to the Reef Fish Management Plan to Set 1999 Gag/ Black Grouper Management Measures."

No maps were drawn for Alternatives 5 and 6, which were considered and rejected.

No areas were identified for Alternative 7, and therefore no maps were drawn.

HAPC candidate areas were identified under Alternative 8, based on maps of metrics used to evaluate habitat condition relative to the four considerations in the EFH Final Rule. The polygons of these areas were taken from these maps and presented on a separate map using the GIS.

2.1.5 Addressing adverse effects of fishing on EFH

2.1.5.1 Introduction

Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature. Each FMP must therefore be amended, as necessary, to prevent, mitigate, or minimize to the extent practicable adverse effects from fishing on EFH, including EFH designated under other Federal FMPs (600.815(a)(2)(ii)). In addition, Federal agencies must consult with NOAA Fisheries on Federal actions that may adversely impact EFH. These requirements recognize that both fishing and non-fishing actions may adversely affect fisheries productivity through a variety of impacts on EFH.

2.1.5.2 Evaluation of fishing impacts on EFH

This EIS evaluates, to the degree practicable, the relative risk of impacts to EFH resulting from fishing activities. This provides the basis for developing alternatives to prevent, mitigate, or minimize adverse effects of fishing on EFH. The evaluation occurs in several steps that are illustrated in Figure 2.1.2 and listed below:

1. prepare habitat maps and identify EFH;
2. develop an index of the sensitivity of fish habitats to fishing impacts, by gear;
3. determine the extent of the fishing activity, by geographic location and gear (fishing effort);
4. combine the sensitivity index and the fishing effort into a spatially structured index of fishing impacts, by gear and habitat; and
5. develop alternatives that potentially reduce the fishing impacts index and thereby prevent, mitigate, or minimize adverse effects of fishing on EFH.

The process illustrated in Figure 2.1.2 also goes beyond the stage at which the alternatives are developed and illustrates the types of considerations that comprise the analysis of environmental consequences and the practicability of the alternatives, particularly in the context of cumulative impacts (see Section 2.1.6.3).

Steps 1 and 2 in the list above were completed, to the extent possible, under the EFH and HAPC components of the EFH mandate respectively. The results of the habitat mapping effort are described in Section 3.2.3.1. Available information on the effects of fishing on habitat is reviewed in Section 3.5.2. The development of the fishing sensitivity index is described in Section 2.1.4.2.1.1. This analysis resulted in a matrix of fishing gear sensitivity by gear and habitat that is described at the beginning of Section 3.5. While these sensitivities are somewhat subjective in nature, they are essentially a function of two components: the sensitivity of the habitat to perturbation and the nature of the fishing impact. This sensitivity is independent of the actual intensity of the impact to which the habitat is subjected. The measure of this intensity is provided by data on fishing effort.

2.1.5.2.1 Fishing effort

To determine the impacts to habitat caused by fishing, it is necessary to have fishing effort data broken down by location on as fine a scale as possible, preferably haul-by-haul, including start and end points for deployed gears. Haul-by-haul data would allow detailed analyses of the proportion of each habitat type actually impacted, and the proportion and frequency of repeat impacts on the same patch of habitat compared to the proportion of impacts on virgin habitat. Effort data for commercial fisheries in the Gulf of Mexico are available only in an aggregated form, on a trip-by-trip basis through logbook, trip interview programs, or trip tickets. Multiple trips are assigned to a statistical area on a map – for example one of the 21 NOAA Fisheries statistical grid units (Figure 2.1.3), or depth sub-divisions within that grid in the case of shrimp trawls. Haul-by-haul data are not available, and therefore the analysis of fishing impacts is restricted to a relatively low level of precision.

The Marine Recreational Fisheries Statistical Survey (MRFSS), conducted by NOAA Fisheries, collects recreational fishing data using two complementary methods: random telephone surveys of households in coastal communities (within 50 miles of the coast for the Gulf) and in-person intercept interviews at fishing access sites. Telephone surveys collect information on the number of: anglers (if any) in each household, fishing trips made in the past 2 month period, the county where the trips were made, and the mode of fishing (head/charter boat, private/rental boat, shoreline-based). In-person intercept surveys record information on the number, length, and weight of each species caught; the angler's state and county of residence; the mode of fishing; number of fishing trips made in the past 12 months; and the primary area fished (i.e. inland bays and estuaries, ocean areas < 3 miles from shore, ocean areas > 3 miles from shore). The information from these survey methods is used to generate estimates of fishing effort (number of trips made) and overall catch, as well as catch by species or aggregations of species (e.g. epinepheline groupers). These estimates are calculated so that they can be stratified by state, fishing mode, 6-month or annual periods, and fishing area.

For effort data, outliers in the dataset are removed from the analysis. Their removal may cause a slight bias in the effort estimates, but greatly reduces the variance of the estimate. Pooled multi-year datasets are sometimes used in cases where sample size is low and variability is high, usually for head boat and charter boat effort information. Once again this may bias estimates somewhat, and obscure short term phenomena, but reduces the variance of estimates. Missing data from telephone surveys are filled in using imputed data where possible. The use of imputed data tends to cause a small increase (~ 5%) in effort or catch estimates. Missing fish weight data from intercept surveys are filled in using length-weight equations. Species with very low catches are often pooled together in aggregate groups and catch estimates generated on that basis. In some cases, a particular state and time period may record unusually large catches of a species or a pulse fishery, which may result in high estimates of catch. Such anomalies can be detected by looking at catch trends over time. More information on MRFSS data collection methods and statistical considerations can be found on the MRFSS website at http://www.st.nmfs.gov/st1/recreational/.

Limitations of using MRFSS data to examine patterns of recreational effort Gulf-wide stems from the relatively broad scale of spatial resolution associated with the data (i.e. state by state by the primary area fish). This level of information did not allow detection of fine scale differences in recreational fishing effort within the Gulf.

The following table lists the maps of fishing effort that were prepared from the available data sources discussed (see Appendix I for additional details). The maps and a discussion of information on fishing effort are provided in Section 3.3.1. Initial analyses examined multi-year fishing effort datasets for increasing or decreasing effort trends. Because no obvious fishing effort trends were seen among gears, it was decided that the two most recent years of effort information should be used for each gear. This information was believed to best reflect the level of recent effort and also be the most accurate fishing effort information available.

In an effort to assess the amount of recreational vertical gear fishing effort in the Gulf of Mexico relative to commercial vertical gear effort, landings of selected reef fish species and species groups (principally snappers and groupers) were compared between the recreational and commercial fishing sectors on a state-by-state basis. Comparisons of recreational landings (from MRFSS) to commercial landings (NMFS 2003) varied widely depending on the fish or fishes involved, and in which state the fishing was occurring. In addition, while recreational and commercial fishers often harvest the same areas, they generally fish at different times of the year. Recreational fishers typically use some form of hand-powered rod and reel to catch fish, but commercial fishers use a wider variety of vertical gears such as bandit gear and electric/hydraulic reels, often with multiple hook configurations. Because of these differences, recreational vertical gear was treated as a separate fishing gear from commercial vertical gears.

Map (gear)	Method/Units	Data source
Reef fish handline	For an individual trip, the number of hours that lines were fished was calculated by multiplying the number of lines fished during a trip times the number of hours fished during a trip. These numbers were then summed for each of 21 NOAA Fisheries fishing units for each year. Data showed significant year-to-year variability. The average of the two most recent years is plotted from among Logbook data for 2000-2001	Logbook data 1990-2001
Recreational vertical gear – Charter / Headboat – Private and Rental boats – Shoreline	The MRFSS dataset was queried and the results analyzed to determine the number of recreational trips made annually in each Gulf state (except Texas). An average was taken of the data in 2000 and 2001. Analyses were done individually for Party/Charter boat trips, Private/Rental boat trips, and Shoreline fisher trips. Information for Texas recreational fishing was supplied by the Texas Parks and Wildlife Department (Texas sport-boat angler trips for the 1999-2000 and 2000-2001 survey years). Regardless of the dataset used, within each fishing mode distinctions were made between fishing in inland waters (i.e. estuaries, bays, sounds, etc.), state territorial seas (from the shoreline to 3 nautical miles out for AL, MS, &LA; and to 9 nautical miles out for FL & TX), and Federal waters (from state waters boundaries to 200 nautical miles out in the Gulf). Texas does not collect information on shoreline fishing. An estimate of Texas shoreline fishing was made based on what proportion of total Gulf recreational fishing	MRFSS, Texas parks and wildlife

Map (gear)	Method/Units	Data source
	effort Texas represented for the other two fishing modes. This proportion was used to extrapolate a rough estimate of shoreline effort in Texas based on shoreline effort in the other Gulf States.	
Reef fish bottom longline	Effort for an individual trip was determined by taking the number of sets made during the trip and multiplying this by the average length of longline used (in miles). These numbers were then summed for each of 21 NOAA Fisheries fishing units for each year. Data showed significant year-to-year variability. The average of the two most recent years is plotted from Logbook data for 2000-2001	Logbook data 1990-2001
Reef fish trap	Number of traps hauled in each of the 21 NOAA Fisheries Gulf of Mexico fishing units averaged for the two most recent years	Logbook data 1990-2001
Coastal pelagics handline	For an individual trip, the number of hours that lines were fished was calculated by multiplying the number of lines fished during a trip times the number of hours fished during a trip. These numbers were then summed for each of 21 NOAA Fisheries fishing units for each year. Data showed significant year-to-year variability. The average of the two most recent years is plotted from Logbook data for 2000-2001.	Logbook data 1990-2001
Spear usage (i.e. spearfishing by divers)	For an individual trip, effort was determined by multiplying the number of divers fishing by the numbers of hours fished. These numbers were then summed for each of 21 NOAA Fisheries fishing units for each year. Data showed significant year-to-year variability. The average of the two most recent years is plotted from Logbook data for 2000-2001.	Logbook data 1990-2001
Powerhead usage (i.e. powerhead fishing by divers)	For an individual trip, effort was determined by multiplying the number of divers fishing by the numbers of hours fished. These numbers were then summed for each of 21 NOAA Fisheries fishing units for each year. Data showed significant year-to-year variability. The average of the two most recent years is plotted from Logbook data for 2000-2001.	Logbook data 1990-2001
Shrimp trawl effort	Annual total number of days fished in each of the 21 NOAA Fisheries Gulf of Mexico fishing units among depth zones (divided into 10 fathom increments). Data are the average of the two most recent years (2000-2001).	NOAA Fisheries Shrimp Effort data
stone crab trap	Annual total number of traps set in each of the 21 NOAA Fisheries Gulf of Mexico fishing units among depth zones (divided into 5 fathom increments). Data are the average of the two most recent years (2000-2001).	Florida Trip Ticket Database (from FMRI & SEFSC)
Spiny Lobster	Annual total number of traps set in each of the 21 NOAA Fisheries Gulf of Mexico fishing units among depth zones (divided into 5 fathom increments). Data are the average of the two most recent years (2000-2001).	Florida Trip Ticket Database (from FMRI & SEFSC)
Shark bottom	Effort for an individual trip was determined by taking the number of sets made during the trip and multiplying this by the average	Logbook data 1990-2001

Map (gear)	Method/Units	Data source
longline	length of longline used (in miles). These numbers were then summed for each of 21 NOAA Fisheries fishing units for each year. Data showed significant year-to-year variability. The average of the two most recent years is plotted from Logbook data for 2000-2001.	

2.1.5.2.2 Fishing impacts index

All fishing has an effect, to varying degrees, on the marine environment, and thus on its associated habitats. This is true even if one considers only the effects of removal of fish. The nature and magnitude of habitat effects depend greatly on the type and intensity of fishing activity and the physical and biological characteristics of the fished area.

The measures of fishing effort described in the previous section are all laid out on the NOAA Fisheries statistical grid. Some, such as the shrimp data, are further divided into depth ranges. We assume that the fishing effort allocated to a unit of area is evenly spread over that area, because there were no data available to allocate effort on a finer scale. No more fine scale data could be made available within the time frame of the preparation of this EIS. More fine scale effort data, such as those available from a Vessel Monitoring System (VMS) would enable an analysis of fishing impacts on a spatial scale more relevant to impacts on habitat. Such data would enable a spatial and temporal analysis of the actual frequency with which areas are affected by specific gears, and the extent to which areas are repeatedly impacted, or previously un-impacted areas are affected.

Given that the areas of the grid units are not uniform, the effort must be divided by the area of the unit. These areas were calculated in the GIS. The fishing impacts index is then calculated using the following simple formula:

$$\text{Fishing Impacts Index (by gear, substrate and grid unit)} = \text{Sensitivity (by gear and substrate)} \times \frac{\text{fishing effort (by gear)}}{\text{area to which the effort applies}}$$

The area to which the effort applies is either an entire grid unit, or a depth range within a grid unit, or the portion of the grid unit that is open to the fishing gear in question. The results of this analysis are presented and described in Section 3.5.2.2.

Through this approach it is possible to demonstrate where some of the interactions from the table of fishing sensitivities that were previously considered to be potentially more than minimal and not temporary, are in fact minimal and temporary by virtue of the low level of fishing effort actually applied.

2.1.5.2.3 Limitations of the analysis of fishing impacts

One of the major aims in the analysis of data for the Gulf of Mexico is to find ways to show contrast in the relative probability of impacts between one location and another. Demonstrating contrast enables managers to focus their attention on the areas most at risk and most in need of protection. This concept is central to the process of identifying EFH and HAPC. It applies equally to the identification of adverse impacts from fishing. However, major difficulties were encountered in achieving this aim because the level of information available, particularly on a geographic scale, was generally low. This is demonstrated very clearly by the poor resolution in the fishing effort data, which was a major constraint to the analysis. The scale of some of the areas of habitat mapped in the GIS is much smaller than the scale of the fishing effort data. Without some means to allocate fishing effort on a scale similar to the habitat information, it is very difficult to realistically represent relative impacts on habitat across a large area such as the Gulf of Mexico.

There has been no attempt to represent impacts from fishing gears in a cumulative sense. That is, to add the impacts of one gear to another to look at the potential combined effects. This can be done qualitatively by a simple overlay of the fishing impacts index maps one on top of another. However, there is no clear basis for adding the impacts of a mobile trawl (for example) to those of a fixed longline on a Gulf-wide basis. Impacts have therefore been deliberately depicted on a gear-by-gear basis.

In a dynamic context, damage from a fishing gear impact combines with habitat recovery in some functional relationship to obtain a net level of habitat impact over time. However, with available data it has not been possible to measure the frequency with which a particular piece of habitat will be impacted, and therefore the amount of time the habitat will have to recover relative to the amount of time it needs before the next impact event. In essence this component of the impact has been subsumed within the sensitivity index, and is hence, highly uncertain.

Much of the information used in the analysis of adverse fishing impacts has a high degree of uncertainty. In the absence of estimates of that uncertainty, the calculations described in this section treated the available data deterministically. The calculations that develop sensitivity and effort indices, and then multiply these to calculate the impacts index, for example, propagate and compound unknown errors at each step.

To the extent possible, this analysis has recognized the existence of uncertainty by grouping data and results of calculations into categories. Quartiles were used, for example for the sensitivity index. These were selected as a compromise between the desire to show enough contrast among the categories for the analysis to be useful in guiding management decisions, and the need to avoid implying an unrealistic level of precision in the analysis. Whether this balance has been achieved is impossible to tell, because the true level of uncertainty is presently unknown. Ideally, additional development of this methodology would specifically deal with the uncertainty through development of stochastic procedures.

2.1.5.3 Developing alternatives to prevent, mitigate, or minimize the adverse effects of fishing on EFH

2.1.5.3.1 The potential scope of Council action

The Council and NOAA Fisheries can directly implement regulations to modify actions only in Federal waters, unless the Secretary of Commerce elects to use his authority to preempt state management. However, habitat that potentially will be designated as EFH occurs in state waters. In order to extend actions that protect EFH into state waters, the Council will need to establish a cooperative arrangement with the states, or it can make strong recommendations to the states to address adverse impacts from fishing gears on EFH in their jurisdiction. Because many fishery resources occur in state waters, some fishery management programs have extended to the shoreline. However, not all regulations are fully consistent between Federal and state waters.

Of the habitat types that potentially will be described and identified as EFH for one or more species managed by the seven FMPs, the following are those that are potentially impacted by fishing gears fished under Federal permit:

- Reefs (coral)
- Live or hard bottoms
- Submerged aquatic vegetation (seagrasses)
- Sand/Shell bottoms
- Soft bottoms

2.1.5.3.2 More than minimal and not temporary

The EFH Final Rule (50 CFR 600.815(a)(2)(ii)) establishes a threshold for determining which fishing activities warrant analysis to prevent, mitigate, or minimize to the extent practicable the adverse effects of fishing on EFH:

> "Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature, based on the evaluation conducted pursuant to paragraph (a)(2)(i) of this section and/or the cumulative impacts analysis conducted pursuant to paragraph (a)(5) of this section."

As discussed in the preamble to the EFH Final Rule at 67 FR 2354, management action is warranted to regulate fishing activities that reduce the capacity of EFH to support managed species, not fishing activities that result in inconsequential changes to the habitat. The "minimal and temporary" standard in the regulations, therefore, is meant to help determine which fishing activities, individually and cumulatively, cause inconsequential effects to EFH.

In this context, temporary effects are those that are limited in duration and that allow the particular environment to recover without measurable impact. The following types of factors should be considered when determining if an impact is temporary:

- The duration of the impact;
- The frequency of the impact.

Minimal effects are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions. Whether an impact is minimal will depend on a number of factors:

- The intensity of the impact at the specific site being affected;
- The spatial extent of the impact relative to the availability of the habitat type affected;
- The sensitivity/vulnerability of the habitat to the impact;
- The habitat functions that may be altered by the impact (e.g., shelter from predators)
- The timing of the impact relative to when the species or life stages need the habitat.

There has been some considerable debate regarding how to determine specifically whether a particular impact can be described as minimal and temporary. For some interactions it is likely to be quite obvious that the effects of fishing are negligible; for example, the effects of vertical gear on sand/shell bottoms (see Section 3.5.2.1). Similarly there are some interactions that are quite obviously not minimal and more than temporary; for example various kinds of traps on coral reefs (e.g. see Section 3.5.2.1). However, there are likely to be some impacts for which the determination is very difficult to make without considerable supporting data, which for the most part are currently not available. We have therefore taken the view in this EIS that any interactions that cause impacts which cannot be considered to be obviously minimal and temporary, based on existing knowledge of fishing gear sensitivities and fishing effort, will need to have alternatives developed for them.

The method for implementing this in practice was to use the fishing gear sensitivity index, calculated as described in Section 2.1.4.2.2.1. All gear/habitat interactions that had fishing gear sensitivity index scores in the lowest category (0) were considered to fall below the threshold of 'minimal and temporary.' Alternatives were therefore not developed for these interactions. The associated inference, that fishing gear / habitat interactions, with sensitivity scores greater than 0, result in effects on habitat that are more than minimal and not temporary, is not necessarily true. No rigorous, formal, quantitative analysis has been undertaken to determine whether this is the case. Indeed, some of the interactions given a gear sensitivity score of 1 (see Section 3.5.2.1) may be minimal and temporary. To the extent possible, the benefits likely to be realized from all the alternatives to prevent, mitigate, or minimize any adverse effects from fishing are discussed in Section 4 of this EIS.

Of the fishing gears listed in the fishing gear sensitivity index table (see Section 3.5.2.1), those that are known to operate in Federal waters of the Gulf of Mexico and have potential impacts on fish habitat that are more than minimal and not temporary are indicated in the text table below as having alternatives developed. In addition, there are some gears listed in the table, with impacts above minimal and temporary (Blue crab traps/pots, oyster dredges, crab scrapes, and rakes and tongs), which are used in state waters, but not in the EEZ. Recommendations for approaches to mitigating impacts caused by these gears are provided in Section 4.7.1.2 (Conservation Recommendations).

Gear Type	Interactions between gear and habitat for which alternatives were developed and analyzed					Used Only in State Waters.
	SAV	Coral Reef	Hard Bottom	Sand/ Shell	Soft Bottom	
Otter trawl	✓	✓	✓	✓	✓	
Frame trawl	✓	✓	✓	✓	✓	
Longline/buoy gear	✓	✓	✓	✓	✓	
Fish trap/pots	✓	✓	✓			
Stone crab trap/pots	✓	✓	✓			
Lobster trap/pots	✓	✓	✓			
Vertical gear	✓	✓	✓			
Spears/Powerheads		✓	✓			
Oyster dredge	✓	✓	✓	✓	✓	✓
Rakes and tongs	✓	✓	✓	✓	✓	✓
Crab scrapes	✓	✓	✓	✓	✓	✓
Blue crab traps/pots	✓	✓	✓			✓

2.1.5.3.3 Possible Council actions

This section describes the types of actions that were considered when developing the range of fishing impacts alternatives to mitigate potential adverse impacts by a gear on a habitat. Many different actions are possible for each gear, and a subset of reasonable possibilities is presented below by gear type. The actions considered in developing the alternatives fell generally under the concepts of: no action, gear modifications, time/area management and full prohibition of the activity causing the impact. The last three can indirectly result in reduced fishing effort. These concepts are described in more detail in the text table below.

Concept	Description
No action	No action alternatives are required by NEPA in part to provide a baseline for the consequences analysis, against which the consequences of all the other alternatives can be compared. Under this concept, no new measures for preventing, minimizing or mitigating adverse effects of fishing on EFH would be introduced. Adopting this concept as the fishing impacts alternative would require a determination that existing management measures adequately minimize, mitigate, or prevent potential adverse fishing impacts for all gears in all FMPs, to the degree practicable using best available scientific information (see Section 2.5.2 for a more complete rationale for the alternative).
Gear modifications	Under this concept, alternatives are developed for modifications to the design and/or use of specific fishing gears that have a high potential of preventing, minimizing, or mitigating the adverse fishing impacts they cause. Fishing gears to which habitats are sensitive are identified and several alternatives for gear modifications to reduce adverse impacts are proposed.

Concept	Description
Time/area closures	Alternatives create specific closed areas and closed seasons to prevent, minimize, or mitigate adverse fishing impacts in particular areas and at particular times of the year (as appropriate). Such closures can create a type of marine protected area (MPA) for particular gear, fisheries, or seasons.
Reduce effort	Effort reduction can be achieved indirectly through time/area closures and gear modifications and prohibitions. The use of limited access systems (i.e., Individual Transferable Quota (ITQ) or Individual Fishing Quota (IFQ)), are restricted under the M-S act to only those actions designed to achieve optimum yield in a given fishery. ITQs, IFQs or similar mechanisms are not authorized for the purpose of habitat protection, and thus are not considered as potential actions in this EIS.
Gear prohibitions	This is the most restrictive approach to preventing, minimizing or mitigating adverse effects of fishing on EFH. Prohibition of gears on sensitive habitat could occur at two scales. First, prohibit the gear on only the habitats that the gear adversely impacts. This would require mapping of the habitats and drawing enforceable boundaries around the sensitive habitats. Second, prohibit gear throughout the EEZ. Such a prohibition would prevent a gear adversely affecting a habitat (to the extent it is enforced), but would also prevent use of the gear on habitats where it causes no adverse impact.

2.1.5.3.3.1 Previous Council actions

The Gulf of Mexico Council has addressed threats to EFH from fishing activities and has included management measures to minimize these adverse threats since the first FMP was published in the late 1970s. Discussions of fishing activities that could adversely affect EFH are presented in current FMPs, including current management measures that are implemented to minimize effects on EFH from fishing. The conservation and management measures implemented by the Council, to date, include actions that eliminate or minimize physical, chemical, or biological alterations of the substrate; loss of, or injury to, benthic organisms, prey species, their habitat; and impacts to other components of the ecosystem.

Conservation and Management Measures that may reduce habitat impacts include:

- **fishing gear restrictions and modifications, e.g.:**
  - seasonal and area restrictions on the use of specified gear;
  - requested NOAA Fisheries to develop a vessel monitoring system for fish trap vessels;
  - gear modifications to allow escapement of bycatch (BRDs and TEDs) or undersized individuals of particular species or particular life stages (e.g., juveniles);
  - gear modifications to reduce the effects of ghost fishing (e.g. biodegradable panels and escape windows in traps);
  - requiring fish traps to be constantly monitored, individually buoyed, and returned to shore on each trip, to reduce trap loss;
  - prohibiting use of drift gill nets and purse seines for harvesting coastal migratory pelagic fish, reducing bycatch of reef fish;
  - phase-out of the king mackerel gill net fishery, reducing bycatch of reef fish;

- phase-out of fish traps (2007);
- harvest limits;
- license and permit limitations, including limited access systems;
- prohibitions on the use of explosives and chemicals unless approved by Florida;
- recommended prohibitions[5] on anchoring or using certain types of equipment in sensitive areas;
- prohibition of fish traps west of Cape San Blas;
- phase-out of the live rock fishery and requiring permits for live rock aquaculture and hand harvest only;
- prohibition of use of power-assisted tools to harvest gorgonians;
- prohibitions on fishing activities that cause significant physical damage to fish habitat;
- time/area restrictions, including closing areas to all fishing or specific equipment types during spawning, migration, foraging, and nursery activities; and
- designating zones as MPAs to limit adverse effects of fishing practices on certain vulnerable and/or rare areas/species/life history stages.

The history of management of Gulf of Mexico fisheries is described in Section 1. Also see Sections 3.2.4, 3.3.1, and Appendix A.

2.1.5.3.3.2 Possible further actions

Potential actions to mitigate impacts are discussed below for a few selected gears. These are described here to illustrate the types of options that were considered in developing the alternatives. They are not intended to presume particular impacts by particular gears (or not) at this point in the EIS. Gear impacts are discussed in detail in Section 3.5.2.

Traps

Actions to limit, eliminate, or mitigate for potential damage caused by traps could include gear modifications. Buoyancy on traps would minimize the force of impact. However, buoyant gear would tend to drift, which could lead to lost traps and ghost fishing until deterioration of biodegradable panels built into the traps. Requiring buoyancy would not reduce shading effects on SAV. Effective prohibition of traps in open coral, live hard bottom, and SAV areas would eliminate adverse impacts in those areas. Problems enforcing such prohibitions would reduce their effectiveness, and fishing effort might increase in adjacent areas. In addition, fish traps are being phased out over the next few years, and therefore, are considered "status quo" and not needing further restrictions.

Trawls

Actions to limit, eliminate, or mitigate for potential damage caused by trawls could include the establishment of marine reserves, gear, or seasonal zoning. The use of semi-pelagic trawls

[5] This is a general recommendation or statement of concern issued by the Council. It will not have any legal standing unless and until the Council specifically prohibits and defines anchoring and impacting equipment in a specified area through an amendment to one of the Gulf of Mexico FMPs.

would avoid the majority of habitat impacts that demersal trawls are associated with, but catch efficiency may be greatly reduced and enforcement would be difficult. Carr and Milliken (1998) recommended: target certain species and modify gear appropriately, encourage use of lighter sweeps, reduce the sea bottom available to trawlers that fish very irregular terrain, and opt for stationary gear over mobile gear.

Vertical gear

Actions to limit, eliminate, or mitigate for potential damage caused by vertical gear could include eliminating the use of anchors on fragile bottom, using buoys on anchor lines (to reduce likelihood of anchors dragging or sliding across the bottom during retrieval) or the use of circle hooks (to prevent snagging on corals or other live organisms on hard bottom). Difficulties enforcing such prohibitions would reduce their effectiveness.

2.1.5.3.4 Structure of the fishing impacts alternatives

The suite of possible management measures for gears and habitats in the previous section represents an impractical range of choices and potential mixtures of actions for analysis of consequences. Rather than develop each possible action as an alternative, this DEIS presents alternatives that consist of a package of several possible management actions (see Section 2.5). The actions in each alternative are intended to offer logical groupings of measures to address impacts as plausible scenarios for the Council to consider. This range of alternative actions spans the five concepts described in the previous section: no action, gear modifications, time/area management, fishing effort reduction, and full prohibition of the activity causing the impact. These concepts are described in more detail in the text table below. The alternatives arising from these concepts comprise specific actions to be implemented under FMPs that have been organized so that, in general, successive alternatives offer greater restrictions. Each successive alternative tends to add to the measures included in the prior alternative (see Section 2.5).

The alternatives were constructed to provide a reasonable range within the consequences of plausible groupings of measures. This was not intended in any way to restrict the Council's choices, but rather to enable them to make informed decisions. The Council is free to select a different grouping of measures. If this different grouping is close to any of the alternatives analyzed in this EIS then the likely consequences of the Council's preferred grouping would be relatively easy to determine. If, however, the preferred grouping is very different in its structure then it will be necessary to take this alternative and consider its consequences as part of a separate analysis.

2.1.6 Evaluating the consequences of the alternatives

Because the Council and NOAA Fisheries have the authority only to regulate fishing activities and not non-fishing activities (Figure 1.1), this EIS develops alternatives only for preventing, mitigating, or minimizing adverse effects from fishing. The EIS considers the consequences of specific alternatives to address adverse fishing impacts. It also considers in a general way the consequences of anthropogenic, non-fishing impacts and natural impacts. The practicability of the fishing impacts alternatives is considered with regard to the economic and ecological costs and benefits of the resulting management measures, within the overall context of the fishing and non-fishing and natural impacts (see Section 2.1.6.4). The benefits of taking action under the EFH mandate also need to be considered in light of existing and reasonably foreseeable future Council actions that protect habitat. To provide a baseline against which to develop alternatives for new action, the following section describes existing Council actions in detail.

The consequences section (Section 4) forms the scientific and analytic basis for the comparisons of alternatives for the EIS. It consolidates the discussions of those elements required by Sections 102(2)(C)(i), (ii), (iv), and (v) of NEPA which are within the scope of the statement and as much of Section 102(2)(C)(iii) as is necessary to support the comparisons. The discussion includes the environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented.

Section 4 provides an analysis of potential environmental impacts that may result from the implementation of the no action alternative and the other alternatives, including the preferred alternative. Elements such as climate, physiography, and geology are not generally affected by localized activities, although they are presented in Section 4 as required. Section 4 is presented as three main parts:

- Consequences of alternatives to describe and identify EFH;
- Consequences of alternatives to define and establish HAPC; and
- Consequences of alternatives for preventing, mitigating, or minimizing the adverse effects of fishing.

Within each of these sections, the discussion is further broken down into physical, biological, human, and administrative environments.

Of necessity, the analysis of environmental consequences is done with incomplete information and data. The effects of missing information in assessing the environmental consequences of the EFH alternatives are also specifically discussed.

2.1.6.1 EFH and HAPC alternatives

The direct and indirect consequences of the EFH and HAPC alternatives were considered in the context of the physical, biological, human and administrative environments. The direct and indirect impacts of each alternative are discussed qualitatively and compared across alternatives.

Direct impacts may result from controversy surrounding the description and identification of EFH and HAPC. Indirect impacts will occur due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. Second, Federal and state agency actions that may adversely affect EFH trigger consultation and/or recommendations under Sections 305(b)(2)-(4) of the Act. Each alternative was qualitatively evaluated for likely effects on consultations and for likely effects on the process for developing management measures for addressing adverse fishing impacts.

2.1.6.2 Fishing impacts alternatives

The direct and indirect consequences of the fishing impacts alternatives were considered in the context of the physical, biological, human and administrative environments. The results are presented in Section 4.4 of the EIS. The specific methodologies employed in these analyses are described below.

2.1.6.2.1 Biological environment

The fishing impacts alternatives are intended to reduce the risk of adverse impacts to habitat that may negatively impact the productivity of managed species. To assess how much of the risk may have been reduced, the combined actions of each alternative were reviewed in light of the known impacts that particular gear and fishing activities can have on living biota and habitat types in the estuarine, nearshore and offshore environments, as described in Section 3.5.2.

2.1.6.2.2 Human environment

The analysis of consequences to the human environment is composed of two main elements: a cost/benefit analysis and an analysis of the effects on fishing communities. The latter includes an analysis to define fishing communities for each of the five Gulf states, because at this time there are no standard guidelines for delineating the boundaries of a fishing community. This was achieved by combining data from different levels and concepts of place (zip code, homeport and Census Designated Place).

2.1.6.2.2.1 Economic analysis (cost/benefit)

Two primary data sources were used to advance the fisheries economics analysis. The first source was that of commercial landings statistics, compiled and maintained by NOAA Fisheries. This data set provided a monthly census of commercial fish landings, generally collected by NOAA Fisheries at the first-buyer level. The second data source was trip ticket information compiled and maintained by NOAA Fisheries. This data set was comprised of catch information, on a trip basis, submitted by fishermen to NOAA Fisheries. These two data sources, combined with information contained in the various management plans and amendments provided, by and large, the basis for discussion. The information contained in these data sources is summarized in Section 3.3.1

The economic analysis was a traditional cost-benefit analysis in determining welfare changes associated with the various alternatives. It is a standard practice employed by economists to determine whether a given proposed action will yield positive net benefits to society. The results of this analysis are presented in Section 4.3.6. The key elements of economic theory that contribute to this analysis are discussed below.

As noted by Panayotou (1993), "[a] certain amount of environmental degradation is an inevitable consequence of human activity. ...Even the use of renewable resources on a sustainable basis presupposes the mining of the stock down to a level that would generate maximum annual growth (or maximum sustainable yield). Virgin fisheries...reach a natural equilibrium stock where net growth is equal to zero; unless the stock is reduced, there is no sustainable yield to harvest. Therefore, some environmental degradation is inevitable (pp. 4-5)." Therefore, as Panayotou argues, "[t]he question is not how to prevent or eliminate environmental degradation altogether but how to minimize it or at least to keep it to a level consistent with society's objectives (p.5)."

From an economic perspective, one would argue that society's objective should be that of maximizing the net benefits derived from the use of a resource. In a well-functioning market, net benefits would equal consumer surplus (amount society would be willing to pay for a good or service over and above what is paid for the good over all units of the good or service consumed) and producer surplus (returns to scarce resources over and above what is needed to attract those scarce resources into production). However, all markets are not well functioning (i.e., there is a 'market failure'). This is particularly the case when ownership rights are absent (see, for example, Just et al., 1982).

With respect to the problem being addressed, the issue is one of the impacts of fishing activities on essential fish habitat. Specifically, concern has been expressed that fishing activities may be resulting in deterioration of habitat quality. To evaluate the impact of this within an economic framework, consider Portion 1.a of Figure 4.3.1.[6] The curve labeled D-D is a hypothetical demand for Gulf of Mexico produced seafood. The curve labeled S-S is the industry supply curve that is based only on marginal private costs (MPC). The competitive equilibrium output is denoted by Q(c), which occurs at an industry level of effort equal to E(c) in Portion 1.b of Figure 4.3.1.[7]

Private marginal costs, however, may not reflect the marginal costs to society associated with a given activity. If habitat degradation as a result of fishing activities is occurring and if it negatively impacts the welfare of society (including, potentially, future generations), the marginal social costs (MSC) will exceed the marginal private costs; the difference reflecting marginal external costs (i.e., those costs not included in the private decision-making calculus).

[6] While the example provided herein relates only to commercial fishing activities, an analogous example could be provided for recreational fishing activities or even diving, if the later results in significant habitat degradation.

[7] This analysis abstracts from a number of considerations, particularly reciprocal externalities among commercial and/or recreational fishermen not related to habitat degradation. These reciprocal externalities exist in all open-access fisheries. Similarly, enforcement and monitoring costs, if relevant, are not considered in this simplified example.

If all costs were to be considered in the decision-making process (i.e., private production costs and external costs, or externalities), costs to the firm for any level of production would increase. This results in an upward shift in the supply curve, indicating that less would be produced at any output price. In the current example, the curve labeled S'-S' reflects the "true" value of scarce resources (i.e., costs) used in the production process. The economically (allocatively) efficient level of output, based on the inclusion of all costs, equals Q(e), which occurs at an industry level of effort equal to E(e).

While somewhat simplified, this example highlights a number of salient features. First, the competitive equilibrium level of output [Q(c)] exceeds the economically efficient output level [Q(e)].[8] Second, the economically efficient level of effort [E(e)] is less than that which transpires in the competitive situation [E(c)]. Finally, assuming that habitat deterioration is a monotonically increasing function of effort, this simplified example suggests that a certain amount of habitat degradation is acceptable as a result of fishing activities; based on the economic efficiency criteria. Degradation would only be unacceptable if marginal external costs are very high.

Discussing deforestation, Panayotou (1993) states "[a]s long as all costs, including those arising from diminished quantity and quality and lost diversity of forests, have been accounted for; as long as both the productivity and the sustainability of the alternative uses have been considered with a due margin of error; and as long as any side effects of the forest conversion have been paid for by those who generated them, deforestation should be acceptable (p.5)." The same general conclusion would apply to fishing activities.

The largest hurdle involved in translating this theoretical example to a practicable setting relates to, of course, measurement of marginal external costs.[9] If habitat degradation from fishing practices is relatively minor, or if the degradation does not represent any significant additional costs to society (i.e., an externality), the marginal private costs would approximate marginal social costs. If, however, marginal externalities are large, MSC and MPC would diverge by a significant amount, providing *a priori* evidence that government interaction may be warranted to correct the market failure.[10] With respect to the impact on habitat from fishing gears, information is relatively limited. Information on the economic costs (external costs) associated with the impact is even more limited. Hence, from an economic perspective it is difficult to provide any meaningful assessment as to whether government intervention is warranted and, if so, the degree of intervention.

The intent of management measures is to identify and protect essential fish habitat in the Gulf of Mexico. The protection of essential fish habitat will, if necessary, be achieved via a combination of restrictions on fishing activity over habitat of concern. These restrictions will, in theory,

[8] This assumes that the industry is not operating on the backward bending portion of the industry supply curve, the result of fishing beyond MSY.
[9] This statement is not meant to minimize the problems one would encounter in simply measuring demand and private marginal costs. Estimating these curves is a difficult process.
[10] While divergence between MPC and MSC is generally considered to be a necessary condition for government intervention, it is not a sufficient condition. Specifically, the costs of government intervention (including monitoring and enforcement) must be less than the benefits derived therefrom.

culminate in mandated changes in fishing practices and, potentially, additional short term, and possibly long term, costs to the fishing industry (possibly both commercial and recreational).

There are seven alternatives, each comprising a bundle of potential management actions that are proposed as a means of addressing potential impacts on fish habitat. The alternatives vary from unrestrictive (Alternative 1: No Action) to progressively more restrictive. The most restrictive (Alternative 5) would significantly limit the types of gears that could be used over a large number of habitats (i.e., coral, hard bottom, SAV, and sand/soft sediments). Alternative 6 was developed as the preferred alternative based on a selection of management actions contained in alternatives 2 and 4, plus a new action. Alternative 7 was added to the EIS based on comments received during the 90- day public comment period that requested more consideration of particular fishing gear impacts on live hard bottom.

As one progresses through the different alternatives, short-term costs to the fishing industry would certainly increase, although changes in long-term costs are more difficult to specify, even on a qualitative basis. The benefits from these gear restrictions, while considerably less certain, would, in theory, increase as additional restrictions are placed on various gears used on different habitats assuming that (1) gear usage is detrimental to different types of habitats and (2) the habitat serves some economic function.

Economic benefits from government intervention (a given action to protect the habitat) include the sum of expected changes in: (1) producer and consumer surplus for landings from the commercial fishery, (2) potential changes in consumer surplus derived from recreational fishing and diving trips[11] (3) potential changes in consumer surplus derived from non-consumptive use values related to the environmental services in question, and (4) passive use value (e.g., existence value). Net economic benefits are calculated by subtracting management costs (e.g., Plan and Amendment preparation, enforcement, and monitoring).

Since information related to the economic value of the different habitats (including the functional relationship of habitat to carrying capacity, relationship between carrying capacity and fishing effort, and passive use benefits; including existence values) are insufficient to make the calculations implied by the last paragraph, much of the benefit/cost analysis was qualitative in nature. Specifically, no attempt was made to place a dollar value on any gains or losses that might result from the alternatives. While analysis was qualitative, existing information was not ignored because available information can be used along with theoretical considerations to produce the best estimate as to the possible economic outcome of the proposed alternatives.

The proposed alternatives, with the exception of Alternative 1 (No Action) entail restrictions on fishing practices of one form or another. These restrictions are designed to restore and/or protect ecosystem integrity (essential fish habitat). As is generally the case, more restrictive fishing practices entail greater short-term economic losses in producer and consumer surplus (i.e., a reduction in economic benefits). These restrictive fishing practices are enacted, however, in expectations that there will accrue some longer-term benefits in the form of higher population size and productivity than would be the case under the no-action alternative. These benefits result from enhanced habitat integrity and function or, at a minimum, a reduction in the rate of

[11] To be more specific, diving trips which are conducted, at least in part, for the harvest of fish.

decay of habitat integrity and function (caused by fishing) and associated reduction in carrying capacity, which ultimately determines available long-run stocks at different levels of effort.[12] At a minimum, this presupposes that gear interaction (certain types) with different habitats (certain types) results in negative impacts to habitat. Some of the increased benefits may be reduced over time if expansion of effort (either commercial or recreational) is not curtailed in the long term.

The period of a cost/benefit analysis is often critical and can change the direction of the outcome. In the short term, for example, a gear restrictions imposed to protect/enhance critical habitat are likely to result in technological inefficiencies in the commercial fishing fleet. This causes a decline in industry profits (since costs per unit of catch increase) and, potentially, even the level of harvest (which may result in a reduction in consumer surplus).

Restoration of habitat quality, however, may, in certain instances, enhance carrying capacity of those stocks dependent upon it during different life stages. This increase in carrying capacity would translate into a larger available stock at any level of effort. The larger stock, while initially translating into increased profits for the fleet will, in the absence of a comprehensive effort control system, encourage additional entrants into the fleet as well as a possible expansion in effort among the existing fleet. This increased effort, in the long term, will dissipate much of the industry profits tied, initially, to habitat enhancement and concomitant increase in carrying capacity and stock size.

As suggested by the above discussion, producer and consumer surplus associated with the production and consumption of landed product can vary in relation to the time-frame of analysis. There may also exist non-consumptive (e.g., diving) and passive (i.e., utility associated with the knowledge that a relatively undisturbed habitat ecosystem exists) benefits associated with protection of the habitat. These benefits may be increasing consistently over time (though probably at a diminishing rate) up to the point that habitat is fully restored.

2.1.6.2.2.2 Socio-economic analysis (fishing communities)

Methodology for defining fishing communities

Previous descriptions of fishing communities tied to particular management actions have provided an indication of the difficulties in defining community and a community's relation to fishing dependence (Aguirre International, 1996; Impact Assessment, Inc., 1991; NPFMC, 1994; Johnson and Orbach, 1996). Griffith and Dyer (Aguirre International, 1996) developed a typology of fishing community dependence for the Northeast Multi-species Groundfish Fishery (MGF). In that typology, the authors identified indicators of dependence which included specific physical-cultural and general social-geographic indicators, i.e., number of repair/supply facilities; number of fish dealers/processors; presence of religious art/architecture dedicated to fishing; presence of secular art/architecture to fishing; number of MGF permits; and the number of MGF vessels. Using previous results and rapid appraisal they developed a fishery dependence

[12] The habitat may, in theory, deteriorate even in the absence of fishing activities due to other anthropogenic or natural forces. If so, restrictions on fishing practices will merely reduce the rate of decay.

index score for the five primary ports in the MGF. As a result they were able to document five variables that best predicted dependence upon the MGF:(1) relative isolation or integration of fishers into alternative economic sectors, including political participation;(2) vessel types within the port's fishery;(3) degree of specialization;(4) percentage of population involved in fishery or fishery-related industries; and (5) competition and conflict within the port, between different components of the MGF (Aguirre International, 1996).

McCay and Cieri (2000) recently compiled a social and economic profile of the fishing ports and coastal counties of the Mid-Atlantic region. In their study they used a variety of sources for information: (1) Federal census and employment data, analyzed for the counties associated with the commercial fisheries of each state; (2) NOAA Fisheries weigh-out data on 1998 landings, by species, gear-type, and port, together with similar data, by county, from the state of North Carolina; and (3) field visits and interviews. Their approach was to identify fishing communities recognized as "ports" by the port agents of the NOAA Fisheries.

Detailed community profiles have been conducted in Alaska to understand the impacts of harvest allocation on communities and on fisheries (Impact Assessment, Inc., 1991; NPFMC, 1994). These profiles utilized census data, permit data, and other available reports supplemented by ethnographic data collection for each community. The profiles provided baseline data to facilitate social impact assessment for license limitation management of the ground fish and crab fisheries.

Johnson and Orbach (1997) combined several counties into management areas, which reflected many sociological, ecological and environmental differences; differences, which were reflected by the types of fishing, found in the various fishing communities. Although they did not attempt to define dependence or specify specific fishing communities, they did contend that management of fisheries would be enhanced if it were to take into consideration the broader social and ecological realities of fishermen's behavior.

More recent research to identify fishing communities has been undertaken in both the Northeast and the Southeast. Hall-Arber *et al*. 2001 used several approaches in assessing a community's dependence upon fishing. One was a regional model of fishing-related employment compared to alternative employment. Another focused on fishing structure complexity and the degrees of individual communities' gentrification and the third approach used community profiles with detailed port characteristics and stakeholder views on community, way of life, institutions and fisheries management. They conclude that a regional analysis reflects the incorporation of a fishing component into economy of contemporary coastal communities.

In their study of Florida fishing communities, Jacob *et al*. 2001 used a protocol based on central place theory which combined Federal and state fishing permit data and census employment data aggregated at the Zip code level to sort population centers and their surrounding hinterlands into central places for the entire state of Florida. Zip code was used for the basic unit of aggregation because it is a geographic identifier for many forms of commercial and recreational fishing data, it is also a relatively small unit of measure, and its boundaries form a service delivery area. To account for the embedded nature of economic linkages in fishing communities, regional economic multipliers for employment were used to estimate the number of jobs that were directly and indirectly related to fishing in each community. Based upon their measure of dependency a small number of coastal communities were determined to be dependent upon fishing. However, using such a dependency measure is not without its drawbacks as concerns about the undercounting of certain occupations within the census data and the inability to satisfactorily measure the recreational sector in terms of its contribution to the local economy are noted.

Because there has been little or no research to document fishing communities in the Gulf of Mexico, this description of fishing communities as part of the human environment will use a modified approach similar to that used by Jacob *et al*. (2001). Although a regional approach is sometimes warranted, it is apparent that in their Florida research (Jacob *et al*., 2001) some fishing communities become subsumed within the larger service sector economy of Florida's coastal regions that is fueled by tourism and recreation. While it is true that most Floridians do participate in an economy that extends beyond their community, it is likely that the majority of their needs are met within the confines of that place they consider their home or what we are referring to as a community. It is impossible to determine a community boundary for all individuals. Therefore we have to assume that based upon certain criteria a pre-determined boundary will encompass an area that captures a sense of community for most of those who live within that boundary. Without extensive ethnographic research into social networks and sense of place, it is impractical to assume that we know the exact boundary around a fishing community. For that reason, in this description there will be no definite boundary assumed, however the fishing community will be understood to exist within a range of boundaries.

Data at the census designated place level (CDP) are used for describing the demographic character of most fishing communities. Where Zip code level data only are available (permits, NAIC employment figures), data are compiled for the all Zip codes associated with each CDP. A map, which shows the Zip code boundary for each CDP, is provided along with the outline of the CDP in gray and is presented in Appendix D.

One of the difficulties in using CDP data is that it has been shown that fishermen will often live outside the boundaries of the CDP where their vessel is home ported (Jacob *et al*. 2001). Data at the CDP level will not always have a direct one to one correspondence with other data such as the fisherman's home Zip code or Zip code business patterns for fishing employment locations. Therefore data that correspond to one level of place may not correspond to another. Consequently, it is important to understand these differences when undertaking any assessment of impacts to a community. Furthermore, it has been noted that census data often underreport certain groups of people. Recent research (Kitner 2001) has identified coastal communities and fishing communities as being part of those groups who may not be fully represented by census data.

Because at this time there are no standard guidelines for delineating the boundaries of a fishing community, this description will combine data from different levels and concepts of place (Zip code, homeport and Census Designated Place). Each in its own way may represent some part of a fishing community, but none will represent the community in its entirety without extensive research, as mentioned before. The data presented here will highlight the differences in the types of data used in determining the boundaries of a fishing community and any such impacts that might ensue. For each community, the boundaries of all Zip codes named for the community and the boundaries for its census-designated place will be delineated. The visual inspection of each will demonstrate the differences when comparing data from sources using CDP and sources using Zip codes. To conclude, the communities included in Section 3.3.2 and Appendix D are those that may have substantial fishing activity associated with a certain bounded area for each of the five Gulf States and are recognized by the census as incorporated communities or Census designated places. They do not represent a definitive list of fishing communities within the Gulf of Mexico Fishery Management Council's jurisdiction. While at this time there are no standard guidelines for delineating the boundaries of a fishing community it is unrealistic to refer to these communities as "fishing communities" in strict terms as outlined in the Magnuson/Stevens Act[13]. We can only assume that these communities may be impacted by council action because they have some or substantial fishing activity taking place within each community.

The communities listed here represent a partial and/or incomplete list of communities that could be potential fishing communities. In addition, the criteria that were used to determine vulnerability might not be sufficient in determining all the impacts of regulation and other criteria may need to be considered.

However, because there has been no methodological attempt to identify fishing communities for the GMFMC to date, the communities listed here will have to represent those communities which have the potential for being impacted by the regulatory process of fisheries management. While it is much more desirable to have verification on the ground, this exercise was conducted using secondary data entirely and most often collected for other purposes. Therefore, the communities listed here may be incomplete or imprecise, yet is the best attempt to identify "fishing communities" to date.

Census Demographic and Employment Data

When using census data it is important to state that certain qualification must be understood. As mentioned previously, census data has been notorious for underreporting certain groups of people who have been difficult to contact and therefore include in any census. Commercial fishermen are part of that group as outlined in recent research by Kitner (2001). For that reason, it must be assumed that census data as it relates to fishing communities is highly suspect. As was pointed out in earlier research (Jacob *et al*., 2001) any attempt at quantifying employment or income from commercial or recreational fishing becomes problematic. Data may be suppressed or grossly underreported and therefore any description will miss important economic and social contributions of fishing related businesses.

At the same time, census data is the only demographic data that can be applied over large geographic areas and population ranges. It is easily available and represents the most affordable alternative for describing any community at this time. Although these data are suspect, it can

[13] In 16 U.S.C. 1802 § 3 definitions of the Magnuson-Stevens Act (104-297 (16)), *fishing community* means "a community which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community."

only be assumed that any underreporting is consistent across geographic area and population range. Although this situation is not ideal, by combining several different data from various sources, a general description of community and the fishing activity associated with it may be attained. Until more detailed ethnographic research that can examine the social and economic networks that exist in fishing communities can be undertaken, this general and often broad description of community will have to suffice.

Census demographic data were collected for communities and are included in Appendix E. Those data include the following variables for each community: total population by age; educational attainment; race; industry; occupation; average wage or salary; poverty status. These data were collected for census years 1970, 1980, 1990, and 2000. Census data for the first three decades were compiled using the MARFIN Socioeconomic Database created by the Louisiana Population Data Center. The census data for the year 2000 were compiled from the U.S. Census Bureau's American Factfinder Webpage (http://factfinder.census.gov). In using data from the 2000 census there are several caveats that must be noted. The 2000 census was the first year that individuals were allowed more than one choice when deciding race. Therefore, when comparing the category race to the previous three decades, the correspondence will not be consistent. In order to lessen misunderstanding for this description only those categories where one race alone was chosen were used. In other words, those who chose more than one race were not included. This will result in some underreporting for the year 2000.

Other significant changes in the 2000 census were made to the industry and occupation categories. This was the first decennial census to use the North American Industry Classification Code (NAIC) in replacement of the Standard Industry Code (SIC). The transition to NAIC from the SIC reclassified many industries and occupations, making comparisons between previous census and the most recent, difficult. For the purposes of comparison, certain industry categories were reclassified and compiled to reflect the best representation of the previous classification used in the preceding census. This recoding was done after comparing certain industry classifications, which were moved into other categories with the switch to the NAIC from SIC. While admittedly not perfect, this reclassification was necessary to make comparisons of industry changes over time. The task of reclassifying the occupation category was deemed too onerous and therefore the only category reported for 2000 is the Farm, Fish and Forestry category, which did not change and most likely contains the majority of fishing related employment. An example of how reclassification of these industry categories is included in Appendix G.

Employment data collected by the Census Bureau were also used at the Zip code level for these community descriptions. Again, it must be assumed for reasons stated earlier that these data are likely to underreport actual fishing employment. In addition, the category of fishing that is reported in the economic census does not include those individuals who report themselves as self-employed, of which most commercial fishermen consider themselves. Therefore, employment figures again grossly distort the actual employment from commercial and recreational fishing. In addition, like Jacob *et al*. 2001, employment for the recreational sector was difficult to quantify and the marinas sector is once again used to provide some indication of community employment from the recreational sector. It is recognized that this measure is inadequate and is one component of a much larger employment sector.

Unfortunately, as stated earlier, the secondary data that are available at this time do not lend themselves to a rigorous and completely accurate portrayal of fishing community. Instead, a general and very broad view of community is presented with the aforementioned caveats. Until a much more detailed census of both fishing communities and the fishing industry becomes available, there are few descriptions of fishing communities that will capture the true nature of both the economic and social character of commercial or recreational fishing and their relationship to the community, however it is defined.

Fishing Communities on the U.S. Gulf of Mexico

The communities presented here were partially chosen because of their mention in previous research (Holland *et al*. 1999; Jacob *et al*. 2002; Lucas, 2001; Maril 1995 & 1983; Sutton *et al*. 1999). Although larger metropolitan areas are not always included, it is recognized that they may have substantial engagement in fishing. Therefore, a brief description of that engagement is included when necessary. The difficulty in providing a more detailed description stems from the lack of detailed information on the location of fishing and its related support industries in major urban areas.

The communities listed here represent a partial and/or incomplete list of communities that could be potential fishing communities, as described above. Refinement of the list of fishing communities was made after meetings with the technical review committees and incorporating their recommendations.

Vulnerability Index

To assist in understanding the impacts of regulation an index of vulnerability has been created for each community that assesses employment opportunities and other sociodemographic variables that offer an indication of the quality of life within a community. The index was developed during similar research conducted in the South Atlantic while identifying fishing communities in that region (Kitner *et al*., 2002). It combines several different variables into an index, which measures employment opportunities, poverty rate, and average wage/salary for a community compared to that of the county. It is used as a rapid assessment tool in lieu of a more rigorous analysis, which is unavailable at this time. This index has been constructed and presented as one manner in which to understand the impact of regulations. It should not be used as the only determinant of the impact of regulations and can only be considered a very broad-spectrum measure of vulnerability. Because the data used are from the census primarily, the previous caveats must be considered. In addition, there are many other variables that might be considered important when outlining the concept of vulnerability. These may vary depending upon the region or community. The variables used here are readily available and are offered as one approach to creating a scale for describing vulnerability.

In creating the scale, employment opportunities were considered important and a readily available measure of those opportunities that went beyond the community was sought. Because people often work outside of their community, employment opportunity that goes beyond the boundaries of that community was deemed necessary. Through a comparison of employment at both the county and community level, a more inclusive employment opportunity measure was attempted.

Employment opportunities are examined through the use of a regional economic analysis called shift share. Shift share measures an area's growth rate compared to that of a larger area like that of the nation. The analysis here looks specifically at the changes in employment at the county level and compares that to the national growth rate. Shift share provides a representation of change in employment growth or decline. It is possible to identify possible growth areas or growth industries in the county through the comparison.

The shift-share analysis for each county was found on the internet at the following site: http://www.georgiastats.uga.edu/sshare1.html. It is a service of the Center for Agribusiness and Economic Development at the University of Georgia. Shift-share analysis provides a method to describe the competitiveness of a particular region's industries and to analyze the local economic base. The shift share analysis has three components: the national growth component; the industrial mix; and the competitive share (Hoover, 1975). For this analysis each component variable for the county is then compared to similar variables for each community and a score is given based upon whether it is positive, neutral or negative in the assessment as discussed below.

The national growth component determines which sector was responsible for the majority of growth as determined by the number of jobs created as a result of the national growth component overall. The sector with the most growth using the national growth component is identified and used in the analysis to determine whether or not the community has seen similar growth in a particular sector.

The industrial mix looks at growth in employment for a sector after taking into consideration that which can be accounted by national growth. The sectors with the largest growth are combined and if employment in that county is concentrated in those sectors, then there is a positive industrial mix

Finally, the competitive share component looks at employment after taking into consideration the national growth component and the industrial mix. If there is still positive growth then the area is competitive in securing future jobs.

The poverty component of the index looks at the number of persons under the poverty level as a percentage of total persons in the community and compares that percentage to that of the county. If the percentage is less than that for the county, the value is 1, if the percentage is the same it is 0, and if above it is -1.

The wage/salary component compares the average wage and salary for the community to that of the county. If that average is above the county average then a value of 1 if given, if the average is the same a value of 0, and if the average is below the county average a value of -1 is assigned.

Each component of the index is given one of three values 1, 0 or -1 depending upon how each contributes to the index. A community index score is the cumulative total of positive or negative values derived from employment opportunities, poverty and average wage compared to county levels. Comparing each community variable to the county offers some perspective of performance in relation to surrounding communities. The following description outlines the index structure:

Shift share component

<u>National growth component</u>

1 if jobs in community national growth component are increasing compared to county

0 if jobs in community national growth component are the same compared to county

-1 if jobs in community national growth component are decreasing compared to county

<u>Industrial mix</u>

1 if industrial mix for the county contributes positive employment growth

-1 if industrial mix for the county contributes negative employment growth

<u>Competitive share</u>

1 if competitive share for the county supports positive employment growth

-1 if competitive share for the county supports negative employment growth

Poverty component

1 if poverty in community below county level

0 if poverty in community same as county level

-1 if poverty in community above county level

Average wage/salary component

1 if average wage/salary in community above county level

0 if average wage/salary in community same as county level

-1 if average wage/salary in community below county level

Each community will have a range of possible scores from: not at all vulnerable with a positive 5; to very vulnerable with a -5. The vulnerability index provides a point of reference from which to gauge the impact of a particular regulation. While it may not be a rigorous measure, it at least allows some interpretation of opportunities available to residents of a community in terms of employment and a reflection of economic trends through poverty rates and average wage.

Interpretation of the vulnerability scale might be broken down into three possible aggregate scores:

Not vulnerable	(Index scores from 3 to 5)
Somewhat vulnerable	(Index scores from -1 to 2)
Very vulnerable	(Index scores from -5 to -2)

Again, it is worthwhile to note that the vulnerability index is part of the larger description of fishing communities. While it does provide a method of assessing vulnerability, there are other factors that may need to be considered when assessing the impacts of regulations. In some cases, the index may not capture the true sense of vulnerability. Therefore, consideration of the index along with other information that may be available for a community is highly recommended and encouraged.

A more detailed description of each community's vulnerability score is included in the Fishing Community Description (Appendix D), which provides the census, and shift share data used for compiling the scale score.

2.1.6.2.3 Administrative environment

Each of the Federal laws and policies that have some relevancy to management of marine waters, habitats or fisheries or other marine resources was researched and summarized for the Administrative Environment section, Section 3.4. The identification of EFH , HAPCs or potential restrictions on fishing activities may have some impact on other Federal laws and policies and these are assessed in Sections 4.2.5, 4.3.5, and 4.4.5.

The implementation of a number of Federal, state, and local laws, regulations, and policies have a direct effect on habitat and waters that may be considered essential habitat or habitat areas of particular concern to the fish species managed by the Gulf of Mexico Fishery Management Council and NOAA Fisheries. As mentioned in Section 2.1.3.1, the designation of essential fish habitat (EFH) requires other Federal agencies with responsibility for proposed non-fishing actions to consult with NOAA Fisheries on actions with potential adverse impacts on EFH. Consultation with NOAA Fisheries was required prior to the reauthorization of the M-S Act in 1996, however the responsible Federal agency did not have to acknowledge or officially respond to NOAA comments in writing. The resulting changes in the M-S Act now require the responsible Federal agency to respond in writing with the rationale for whatever decision it makes contrary to NOAA Fisheries recommendations.

In addition to Federal laws and policies, an overview is provided describing the involvement of states and local governing authorities to the management of marine resources, and potential impacts that the identification of EFH , HAPCs or potential restrictions on fishing activities may have on state and local laws, policies and activities are also assessed in Sections 42.5, 4.3.5, and 4.4.5. The overview includes a description of the primary regulatory agency that manages state marine resources for each of the Gulf states.

2.1.6.3 Cumulative impacts

2.1.6.3.1 Cumulative impacts of alternatives

"Cumulative impact" is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions (CEQ regulations Sec. 1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

To the extent feasible and practicable, FMPs should analyze how fishing and non-fishing activities influence habitat function on an ecosystem or watershed scale (§ 600.815 (a) (6) (i)). This analysis should describe the ecosystem or watershed; the dependence of the managed species on the ecosystem or watershed, especially EFH; and how fishing and non-fishing activities, individually or in combination, impact EFH and the managed species; and how the loss of EFH may affect the ecosystem. An assessment of the cumulative and synergistic effects of multiple threats, including the effects of natural stresses (such as storm damage or climate-based environmental shifts), and an assessment of the ecological risks resulting from the impact of those threats on the managed species' habitat should also be included. For the purposes of this analysis, cumulative impacts are impacts on the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time.

2.1.6.3.2 Evaluating non-fishing impacts

Evaluation of non-fishing impacts uses the procedures described under the HAPC considerations (Sections 2.1.4.2.2.2 and 2.1.4.2.3).

2.1.6.3.3 Practicability

The EFH provisions at 16 U.S.C. §§ 1853(a)(7) state that each FMP shall identify EFH and "minimize to the extent practicable adverse effects on such habitat caused by fishing…." In this context, "practicable" was interpreted to mean "reasonable and capable of being done in light of available technology and economic considerations." In other words, a gear modification is "practicable" if the technology is available and effective, and will not impose an unreasonable burden on the fishers.

The EFH regulations at 50 CFR 600.815(a)(2)(iii) provide guidance on evaluating the practicability of management measures:

"In determining whether it is practicable to minimize an adverse effect from fishing, Councils should consider the nature and extent of the adverse effect on EFH and the long and short-term

costs and benefits of potential management measures to EFH, associated fisheries, and the nation, consistent with national standard 7. In determining whether management measures are practicable, Councils are not required to perform a formal cost/benefit analysis."
In evaluating the practicability of the identified management measures, the EIS considered and compared economic and ecological costs and benefits of those measures. The economic background is discussed in detail in Section 3.3, and costs and benefits of the alternatives are discussed in Sections 4.3 and 4.4 of the EIS. The costs of management measures, whilst complex to determine given available data, can be estimated on a relative basis given expected changes in allowable catch and effort, and hence economic condition for fishers. However, the ecological costs and benefits (of taking or not taking action) are substantially harder to evaluate. In essence, the benefits of specific actions to protect or restore habitat are not all readily quantifiable in the same units as the costs (essentially money). It is therefore very difficult to make direct quantitative comparisons and hence give specific quantified answers to questions of practicability. This is in part due to uncertainty in the direct effects of fishing gears on habitat function and the lack of information on the relationships between habitat function and the productivity of managed species (see Section 2.1.3). This uncertainty and lack of information is both a consequence of and exacerbated by the complexities of the ecological relationships and processes involved.

This problem has been recognized and studied by several authors. (e.g. Costanza et al. 1997) and attempts have been made to estimate the value of various "ecosystem services," including those provided by EFH. Such studies tend to agree that this type of valuation is very difficult to do and fraught with uncertainties. It also seems likely that any estimates that are calculated will be at best minimum estimates, or more likely under estimates. Costanza et al. (1997), however, agree that quantification of the value of the ecosystem is a worthwhile objective, citing among other benefits, the value of such estimates in project appraisal, i.e. in the preparation of EISs such as this one. Quantitative information would allow summing of the various components of benefits in comparable units to the costs, leading to a determination of the net costs or benefits of one alternative relative to another. This would provide an objective basis for the choice of preferred alternatives by the Council.

No quantification of the economic value of the fish habitat of the Gulf of Mexico has been undertaken and such an analysis is outside the scope of the EIS, for reasons of both available time and cost. Without quantified benefits to balance against the costs, decisions about practicability of one alternative relative to another become largely subjective. This does not mean that science is excluded from the process. Qualitative information may be scientific in nature. However, deciding on what is practicable and what is not will depend on how the components of costs and benefits are weighted. Without a detailed quantification of the trade-offs, it is difficult to develop a strictly scientific basis for how to weight the information. Interpretation of the quantitative and qualitative information provided in this EIS will involve judgment by decision-makers. This EIS presents the best available scientific information to resource managers to support informed decision making, to the extent that this is possible at this stage.

The EIS used specific practicability factors relevant to EFH Final rule requirements to evaluate these concepts. The practicability factors used for the Gulf of Mexico consist of the five items listed below.

Practicability Factor	**Relevance to 50 CFR 600.815(a)(2)(iii):**	**Description**
Net economic change to fishers	The long and short-term costs and benefits of potential management measures to: • Associated fisheries • the nation	Changes in short-term and long-term economic conditions of fishers as a result of fishing impacts alternatives
Equity of potential costs among communities	The long and short-term costs and benefits of potential management measures to: • fishing communities	Changes in short-term and long-term economic conditions for communities dependent on fisheries or vulnerable to fishing impacts alternatives
Effects on enforcement, management, and administration	The long and short-term costs and benefits of potential management measures to: • associated fisheries • the nation	Changes in requirements or effectiveness of enforcement, management, and administration as a result of fishing impacts alternatives
Changes in EFH	The nature and extent of the adverse effect on EFH and The long and short-term costs and benefits of potential management measures to: • EFH	Future improvement or degradation in the extent, quality and/or function of EFH resulting from fishing impacts alternatives
Population effects on FMU species from changes in EFH	The nature and extent of the adverse effect on EFH and The long and short-term costs and benefits of potential management measures to: • EFH • Associated fisheries	Magnitude and direction of productivity changes resulting from changes in EFH
Ecosystem changes from changes in EFH	The long and short-term costs and benefits of potential management measures to: • EFH • Associated fisheries	Improvement or degradation of ecosystem function resulting from changes in EFH

These factors were chosen to help identify the costs and benefits to EFH, the fisheries, and the nation. The first factor addresses burdens on fishers, and the remaining four factors address technological availability and effectiveness. Sections 2.2.3 and 2.5 include a summary of the practicability factors for each alternative, and the sections discussing consequences of the alternatives (Section 4.3) contain an analysis of the practicability of each alternative.

2.1.6.4 Evaluating consequences and practicability with limited information

Considering the NEPA regulations in the context of fisheries management, and the lack of sufficient information that generally exists, one of the most important concepts that has received general and widespread acceptance in the scientific community in recent years is the precautionary approach. The International Code of Conduct for Responsible Fisheries (FAO 1995), to which the U.S. is signatory, states that fisheries management organizations should apply a precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment, taking account of the best scientific evidence available. Critically, the absence of adequate scientific information should not be used as a reason for postponing or failing to take measures to conserve target species, associated or dependent species and non-target species and their environment. This has particular relevance in the description and identification of EFH and in developing alternatives to prevent, mitigate, or minimize adverse effects of fishing on EFH

Garcia (1996), cited in Auster (2001) outlines four basic types of environmental management approaches that are based on uncertainty and costs (Figure 2.1.4). The first is a preventive approach that assumes that the uncertainty of information used to make decisions is low. This is action taken in advance of implementation of a management plan to avoid undesirable consequences that can be predicted with a low level of uncertainty. Although the potential cost of errors can range from low to very high, there is a high probability of making correct decisions. When errors are identified after a preventive management action, when unintended consequences of previous actions arise, corrective approaches can be used. In these circumstances, the cost of errors is generally low (even though uncertainty may increase in the types of information used to modify decision making or when new information is applied). This allows trial-and-error types of decision-making in an adaptive framework. When uncertainty increases and the costs of errors increase such that full reversibility of the consequences of a decision is not ensured (but some recovery from actions is highly likely), precautionary approaches should be invoked. Finally, actions under the precautionary principle should be used when uncertainty is very high and the cost of errors may result in irreversible damage.

Although the four basic management approaches have often been discussed in the context of managing fishing mortality (Garcia 1996), Auster (2001) has shown how they can also be applied in a framework targeted at habitat management:

> **"The context for habitat management includes maintenance of the biological diversity of the system from which we wish to exploit particular populations. Preventive approaches are used when there is an understanding of the spatial patterns (and dynamics) of habitat and biological diversity, the linkages between habitat or diversity and the dynamics of the populations of the exploited species, and the spatial distribution and impacts of fishing. Actions within this type of management approach could include spatially explicit gear restrictions (e.g., fixed-gear-only areas or a maximum roller size of trawl ground gear based on restricting access to complex or sensitive habitats), spatially explicit effort limitations based on empirical relationships between effort and the impacts of particular gears, or the strategic use of no-**

> **take MPAs to protect characteristics of particular habitats from gear damage. Corrective approaches are used to fine-tune preventive measures (e.g., adjusting boundaries or times for gear limitations) as new information becomes available. Precautionary approaches are instituted when we know little about linkages between habitat and exploited populations or the relationship between gear impacts and sensitive or long-lived species. For example, no-take MPAs may be designated to protect sponges and corals where a single pass of mobile gear can cause mortality or damage but recruitment of these taxa is sporadic or unpredictable. Actions under the precautionary principle are used when we know the least about the system and the potential for irreversible damage is high to very high such that it is not possible to predict that actions will not irreversibly damage habitats or threaten the extinction of species."**

Auster (2001) further considers threshold values that might trigger the use of various habitat management approaches. He considers that fishing gears with limited effort spread over a large area are unlikely to require conservative restrictions and intensive management intervention in order to protect the function of habitat. Similarly, gears fished at high intensity in a relatively restricted area are unlikely to require management intervention, unless the habitat that is impacted is unique. Auster (2001) provides an example decision tree that is useful in the context of alternatives under this EIS (Figure 2.1.5). The decision tree illustrates the need for ecological understanding about the system within which exploited species occur. The diagram also explicitly demonstrates how reaching the two different thresholds of fishing effects (i.e., when 50% and 80% of the area are impacted – note these are *ad hoc* values chosen for discussion purposes in Auster's paper, although he does indicate that they are based on examples from the literature) causes shifts to increasingly precautionary actions.

According to information compiled for this EIS, there is some understanding in the Gulf of Mexico that a relationship exists between fishing gear and effort and effects on habitat. There is also some understanding of the links between exploited populations and habitat in terms of ecological functions. However, there is little or no understanding of these links in terms of productivity and the specific effects of habitat degradation, past, present and future, on the productivity of managed species. According to Auster's provisional decision framework, it would seem that the types of management measures needed for preventing, mitigating, or minimizing adverse effects of fishing on EFH are a mixture of preventive/corrective and the precautionary approach. The types of actions he suggests under these categories are as follows:

- **Preventive approach**: Restrict effort or gear or use no-take marine protected areas (MPAs) to minimize effects of particular gear types on particular habitats.

- **Corrective approach**: Adjust boundaries or change management measures on the basis of data on habitat recovery and links to population dynamics

- **Precautionary Approach**: Designate no-take MPAs to protect long-lived and sensitive species (e.g., sponges and corals) in areas that do or potentially contain such taxa

2.2 Preferred alternatives

2.2.1 EFH

2.2.1.1 Red Drum FMP – Alternative 6: Areas of higher species density, based on the NOAA Atlas and functional relationships analysis

Alternative 6. EFH for the Red Drum FMP consists of all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from Vermilion Bay, Louisiana to the eastern edge of Mobile Bay, Alabama out to depths of 25 fathoms; waters and substrates extending from Crystal River, Florida to Naples, Florida between depths of 5 and 10 fathoms; waters and substrates extending from Cape Sable, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council between depths of 5 and 10 fathoms (Figure 2.3.1)

This alternative is based on EFH Concept 6.

Density information is available in the NOAA Atlas for adult red drum. The NOAA Atlas portrays the distribution of adults in three categories: Adult Area (Year-round); Commercial and Recreational Fishing Ground (Year-round); and Recreational Fishing Ground (Year-round). For other life stages depicted in the atlas there is only one category, therefore it is impossible to distinguish between areas of different density. Of the three categories for adults, the area of highest relative density was assumed to be the area labeled as "commercial and recreational fishing grounds" (at the time of the 1985 NOAA Atlas creation, commercial fishing for red drum was allowed in all states except for Texas). This area is described and identified as EFH.

For life stages of red drum other than adults, the functional relationships analysis described in Section 2.1.3.3.2 was used to identify areas of habitat with higher relative density. In this analysis, density was described using a qualitative scale similar to the scale used in the NOAA Atlas: no occurrence; occurrence; common; nursery area; and major adult area and commercial fishing ground. All areas of habitat with species/life stage density classified as higher than occurrence were described and identified as EFH. Data on habitats used by substrate type and depth range is described in Section 3.2.4.1.2 and Appendix C.

Figure 2.3.1 provides the composite EFH for the FMP delineated from Vermilion Bay, Louisiana to the eastern edge of Mobile Bay, Alabama out to depths of 25 fathoms; waters and substrates extending from Crystal River, Florida to Naples, Florida between depths of 5 and 10 fathoms; waters and substrates extending from Cape Sable, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council between depths of 5 and 10 fathoms, based on this accounting of EFH for all the life stages of red drum in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.2 and 3.2.3 describe the connections between various habitat types and each life stage in the Red Drum FMU. Section 3.2.4.1.2. states the specific depth ranges at which the Red Drum FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Red Drum FMU.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 6 generally designate EFH at a level intermediate between those of Alternative 1 and Alternatives 2 and 4, so should result in an intermediate level of controversy. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.2.1.2 Reef Fish FMP – Alternative 6: Areas of higher species density, based on the NOAA Atlas and functional relationships analysis

Alternative 6. EFH for the Reef Fish FMP consists of all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100 fathoms (Figure 2.3.2)

This alternative is based on EFH Concept 6.

Density data are available for adults of nine species under the Reef Fish FMP. EFH is described and identified as the areas depicted as major adult area, major commercial fishing ground, commercial fishing ground (for species and life stages where "major commercial fishing ground" is not depicted) according to the following list:

Carangidae—Jacks (1)

Greater amberjack — *Seriola dumerili*-Adult high density as commercial fishing ground

Lutjanidae—Snappers (6)

Mutton snapper — *Lutjanus analis*- Adult high density as commercial fishing ground

Red snapper — *Lutjanus campechanus*- Adult high density as major adult area

Gray (mangrove) snapper — *Lutjanus griseus*- Adult high density as major adult area

Lane snapper	*Lutjanus synagris*- Adult high density as commercial fishing ground
Yellowtail snapper	*Ocyurus chrysurus*- Adult high density as major adult area, major commercial fishing ground
Vermilion snapper	*Rhomboplites aurorubens*- Adult high density as commercial fishing ground

Serranidae—Groupers (2)

Black grouper	*Mycteroperca bonaci*- Adult high density as commercial fishing ground
Red grouper	*Epinephelus morio*- Adult high density as major commercial fishing ground

For all other species/life stages in the Reef Fish FMU, the functional relationships analysis described in Section 2.1.3.3.2 was used to identify areas of habitat with higher relative density. In this analysis, density was described using a qualitative scale similar to the scale used in the NOAA Atlas: no occurrence; occurrence; common; nursery area; and major adult area and commercial fishing ground. All areas of habitat with species/life stage density classified as higher than occurrence were identified as EFH. The data underpinning this analysis are described in Section 3.2.4.2.2 and Appendix C.

Figure 2.3.2 provides the composite EFH for the FMP, delineated to the 100 fathom isobath, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.6 and 3.2.7 describe the connections between various habitat types and each species life stage in the Reef Fish FMU. Section 3.2.4.2.2. states the specific depth ranges at which the Reef Fish FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Reef Fish FMU.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 6 generally designates EFH at a level intermediate between those of Alternative 1 and Alternatives 2 and 4, so should result in an intermediate level of controversy. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.2.1.3 Coastal Migratory Pelagics FMP – Alternative 6: Areas of higher species density, based on the NOAA Atlas and functional relationships

Alternative 6. EFH for the Coastal Migratory Pelagics FMP consists of all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100 fathoms (Figure 2.3.3).

This alternative is based on EFH Concept 6.

Density data are available for adults of all 3 species under the Coastal Migratory Pelagics FMP. EFH is described and identified as the areas depicted as major adult area, and commercial fishing ground (for species where "major adult area" is not depicted), according to the following list:

King mackerel	*Scomberomorus cavalla*- Adult high density as commercial fishing ground
Spanish mackerel	*Scomberomorus maculatus*- Adult high density as commercial fishing ground
Cobia	*Rachycentron canadum*- Adult high density as major adult area

For all other species/life stages in the Coastal Migratory Pelagics FMU, the functional relationships analysis described in Section 2.1.3.3.2 was used to identify areas of habitat with higher relative density. In this analysis, density was described using a qualitative scale similar to the scale used in the NOAA Atlas: no occurrence; occurrence; common; nursery area; and major adult area and commercial fishing ground. All areas of habitat with species/life stage density classified as higher than occurrence are described and identified as EFH. The data underpinning this analysis are described in Section 3.2.4.3.2 and Appendix C.

Figure 2.3.3 provides the composite EFH for the FMP delineated to the 100 fathom isobath, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.13 and 3.2.14 describe the connections between various habitat types and each species life stage in the Coastal Migratory Pelagics FMU. Section 3.2.4.3.2. states the specific depth ranges at which the Coastal Migratory Pelagics FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Coastal Migratory Pelagics FMU.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 6 generally designate EFH at a level intermediate between those of Alternative 1 and Alternatives

2 and 4, so should result in an intermediate level of controversy. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.2.1.4 Shrimp FMP – Alternative 6: Areas of higher species density, based on the NOAA Atlas and functional relationships analysis

Alternative 6. EFH for the Shrimp FMP consists of all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from the US/Mexico border to Fort Walton Beach, Florida from estuarine waters out to depths of 100 fathoms; waters and substrates extending from Grand Isle, Louisiana to Pensacola Bay, Florida between depths of 100 and 325 fathoms; waters and substrates extending from Pensacola Bay, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 35 fathoms, with the exception of waters extending from Crystal River, Florida to Naples, Florida between depths of 10 and 25 fathoms and in Florida Bay between depths of 5 and 10 fathoms (Figure 2.3.4)

This alternative is based on EFH Concept 6.

Density data are available in the NOAA Atlas for adults of all species of shrimp in the FMP, and juveniles of brown and pink shrimp. EFH is described and identified as the areas depicted as major adult area and commercial fishing ground, major adult area, major commercial fishing ground, major adult concentration and major nursery area according to the following list:

Brown shrimp	*Farfantepenaeus aztecus (Penaeus aztecus)*- Adult distribution as major adult area, major adult area and commercial fishing ground, major commercial fishing ground, & Juvenile distribution as major nursery area
White shrimp	*Litopenaeus setiferus (Penaeus setiferus)*- Adult distribution as major adult area, major adult concentration
Pink shrimp	*Farfantepenaeus duorarum (Penaeus duorarum)*- Adult distribution as major commercial fishing ground & Juvenile distribution as major nursery area
Royal red shrimp	*Hymenopenaeus robustus (Pleoticus robustus)*- Adult distribution as major adult area

For all other species/life stages in the Shrimp FMU, the functional relationships analysis described in Section 2.1.3.3.2 was used to identify areas of habitat with higher relative density. In this analysis, density was described using a qualitative scale similar to the scale used in the

NOAA Atlas: no occurrence; occurrence; common; nursery area; and major adult area and commercial fishing ground. All areas of habitat with species/life stage density classified as higher than occurrence are described and identified as EFH. The data underpinning this analysis are described in Section 3.2.4.4.2 and Appendix C.

Figure 2.3.4 provides the composite EFH for the FMP delineated from the US/Mexico border to Fort Walton Beach, Florida from estuarine waters out to depths of 100 fathoms; waters and substrates extending from Grand Isle, Louisiana to Pensacola Bay, Florida between depths of 100 and 325 fathoms; waters and substrates extending from Pensacola Bay, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 35 fathoms, with the exception of waters extending from Crystal River, Florida to Naples, Florida between depths of 10 and 25 fathoms and in Florida Bay between depths of 5 and 10 fathoms, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.17 and 3.2.18 describe the connections between various habitat types and each species life stage in the Shrimp FMU. Section 3.2.4.4.2. states the specific depth ranges at which the Shrimp FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Shrimp FMU.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 6 generally designate EFH at a level intermediate between those of Alternative 1 and Alternatives 2 and 4, so should result in an intermediate level of controversy. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.2.1.5 Stone Crab FMP – Alternative 6: Areas of higher species density, based on the NOAA Atlas and functional relationships analysis

<u>Alternative 6.</u> EFH for the Stone Crab FMP consists of all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from the US/Mexico border to Sanibel, Florida from estuarine waters out to depths of 10 fathoms; waters and substrates extending from Sanibel, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 15 fathoms (Figure 2.3.5)

This alternative is based on EFH Concept 6.

Density data are available in the NOAA Atlas for adult stone crab *Menippe mercenaria*. EFH is described and identified as the areas depicted as major adult area of stone crab.

For all other species/life stages in the Stone Crab FMU, the functional relationships analysis described in Section 2.1.3.3.2 was used to identify areas of habitat with higher relative density. In this analysis, density was described using a qualitative scale similar to the scale used in the NOAA Atlas: no occurrence; occurrence; common; nursery area; and major adult area and commercial fishing ground. All areas of habitat with species/life stage density classified as higher than occurrence are described and identified as EFH. The data underpinning this analysis are described in Section 3.2.4.5.2 and Appendix C.

Figure 2.3.5 provides the composite EFH for the FMP delineated from the US/Mexico border to Sanibel, Florida from estuarine waters out to depths of 10 fathoms; waters and substrates extending from Sanibel, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 15 fathoms, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.21 and 3.2.22 describe the connections between various habitat types and each species life stage in the Stone Crab FMU. Section 3.2.4.5.2. states the specific depth ranges at which the Stone Crab FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Stone Crab FMU.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 6 designates EFH at a level intermediate between those of Alternative 1 and Alternatives 2 and 4, so should result in an intermediate level of controversy. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.2.1.6 Spiny Lobster FMP – Alternative 6: Areas of higher species density, based on the NOAA Atlas and functional relationships analysis

Alternative 6. EFH for the Spiny Lobster FMP consists of Gulf of Mexico waters and substrates extending from Tarpon Springs, Florida to Naples, Florida between depths of 5 and 10 fathoms; waters and substrates extending from Cape Sable, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 15 fathoms (Figure 2.3.6).

This alternative is based on EFH Concept 6.

Density data are available in the NOAA Atlas for spiny lobster adults. EFH is described and identified as the areas depicted as commercial fishing ground.

For all other species/life stages in the Spiny Lobster FMU, the functional relationships analysis described in Section 2.1.3.3.2 was used to identify areas of habitat with higher relative density. In this analysis, density was described using a qualitative scale similar to the scale used in the NOAA Atlas: no occurrence; occurrence; common; nursery area; and major adult area and commercial fishing ground. All areas of habitat with species/life stage density classified as higher than occurrence are described and identified as EFH. The data underpinning this analysis are described in Section 3.2.4.6.2 and Appendix C.

Figure 2.3.6 provides the composite EFH for the FMP delineated from estuaries south of Tarpon Springs on Florida's west coast except Florida Bay; Gulf of Mexico waters and substrates extending from Tarpon Springs, Florida to Naples, Florida between depths of 5 and 10 fathoms; waters and substrates extending from Cape Sable, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 15 fathoms, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.25 and 3.2.26 describe the connections between various habitat types and each species life stage in the Spiny Lobster FMU. Section 3.2.4.6.2. states the specific depth ranges at which the Spiny Lobster FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Spiny Lobster FMU.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 6 designates EFH at a level intermediate between those of Alternative 1 and Alternatives 2 and 4, so should result in an intermediate level of controversy. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.2.1.7 Coral FMP – Alternative 4: Known distributions of species in the FMUs

Alternative 4 EFH for the Coral FMP consists of the total distribution of coral species and life stages throughout the Gulf of Mexico including the East and West Flower Garden Banks, Florida Middle Grounds, southwest tip of the Florida reef tract, and predominant patchy hard bottom offshore of Florida from approximately Crystal River south to the Keys, and scattered along the pinnacles and banks from Texas to Mississippi, at the shelf edge (Figure 2.3.7).

This alternative is based on EFH Concept 4. The NOAA Atlas does not contain distribution information for coral. Adults of coral species use coral habitat. While each coral species will have specific requirements for depth, light, current, etc., available data do not provide the detail necessary for mapping individual species distributions in the Gulf of Mexico, although much work is currently underway. A detailed description of coral reef, patch areas, live banks, etc. is provided in Section 3.2.2.1. Hard and soft coral larvae (plannulae) drift in pelagic waters for several days to weeks, but physical mechanisms apparently retain most larvae near spawning sites (Section 3.2.4.7). Larvae settle on coral and hard bottoms. While corals spawn regularly on a seasonal basis, colonies of juvenile hard corals are rare. Adult coral is its own habitat. Adult soft corals live on hard bottom (see Section 3.1.1.2). The distribution of adult hard coral (see Section 3.1.1.2) is the same as for Alternative 2, but this alternative adds soft corals and the egg, larval and juvenile stages of both hard and soft corals that expands EFH to include all pelagic waters of the EEZ. Figure 2.3.7 provides the composite EFH for the FMP, based on EFH of individual species and life stages.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 4 designates a broad EFH, so should result in a level of controversy opposite that of Alternative 1. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.2.2 HAPC – Alternative 9: The following areas are identified as HAPCs: the Flower Garden Banks, Florida Middle Grounds, Tortugas North and South Ecological Reserves, Madison-Swanson Marine Reserve, Pulley Ridge and the following reefs and banks of the Northwestern Gulf of Mexico: Stetson, McNeil, Bright Rezak, Geyer, Mcgrail Bouma, Sonnier, Alderice and Jakkula.

Under this alternative, the listed areas would be identified as HAPCs. The areas are mapped in Figure 2.3.21. Three of the sites identified are contained in the 21 sites identified under Alternative 8 as meeting three of the four HAPC considerations (Flower Gardens, Florida Middle Grounds, and Tortugas Ecological Reserves). These sites had the following for one or more FMPs: high habitat use index, high fishing sensitivity index, high non-fishing sensitivity index

(Tortugas Ecological Reserves only), and high rarity index. Each site is discrete, and is readily defensible as an HAPC. Although Madison-Swanson did not rank high for ecological importance for many species, the Council chose to include it due to the ecological importance of the habitat to several grouper species, in particular gag, which has been well documented (Sections 3.2.4.2.2.7 and 3.5.1.7).

Pulley Ridge was added to Alternative 9 at the July 2003 Council meeting, following a presentation about the ridge by the USGS. The area is described in Section 3.2.2.1. The region is under a current study by the USGS and university scientists, expected to last several more years. Hermatypic corals and photosynthetic organisms on the ridge survive on only 1-2% of available surface light and the region is unusually productive at 60-70m. Although it is considered by some to potentially be the deepest coral reef in the U.S., until more study is conducted and the evidence is conclusive, the area is classified as living hard bottom for the purposes of this EIS (see Figure 3.1.3). However, the uniqueness of the region has led the Council to add it as an HAPC.

Eight reefs and banks of the Northwestern Gulf of Mexico were added as HAPC under Alternative 9 by the Council at their January 2004 meeting. There decision was based upon new information that was presented by scientists from the Flower Garden Banks National Marine Sanctuary, and supported by public comments to the Draft EIS (see Appendix J). In addition to the Flower Garden Banks, along the edge of the continental shelf margin in the northwestern Gulf of Mexico are hundreds of other lesser known reefs and banks, rising from a water depth of between 400 and 700 feet. The eight named topographical features rise to within 60 feet of the water surface, allowing the development of living coral

The Flower Garden Banks and the Tortugas North and South Ecological Reserves should be identified as HAPCs under the Coral FMP. The Florida Middle Grounds, Madison-Swanson Marine Reserve, and Pulley Ridge should be identified as HAPC under the Reef Fish FMP.

No direct positive or negative impacts to geological features, marine habitats, managed species, marine mammals and protected species, will occur as a result of designating HAPC under this Alternative. Indirect effects are the same as those described under EFH, except that a higher level of scrutiny is justified for HAPC during consultations for activities that may occur within the sites specified.

As the Council's Preferred Alternative for HAPC, these identified sites were taken into special consideration with respect to preventing, mitigating, or minimizing adverse fishing actions (Section 4.3). By implementing the proposed actions under the Preferred Alternative for modifying fishing activities, these sites will have a greater level of protection from adverse fishing activities. Over time, the elimination of these environmentally damaging fishing activities should result in incremental improvements and restoration from past impacts, and better support managed fish stocks dependent upon these sites.

2.2.3 Minimizing the adverse effects of fishing on EFH –Alternative 6

Alternative 6. Establish minor modifications to fishing gears and a gear closures on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

6. Regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs
7. Prohibit bottom anchoring over coral reefs in HAPCs
8. Prohibit use of bottom longlines, buoy gear, and all traps/pots on coral reefs
9. Prohibit the use of trawling gear on coral reefs
10. Require a weak link in the tickler chain of bottom trawls on all habitats

Action	**Coral**	**Hard bottom**	**SAV**	**Sand/soft sediments**
Regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs	[			
Prohibit bottom anchoring over coral reefs in HAPCs	[			
Prohibit use of all bottom longline, buoy gear, and all traps/pots on coral reefs	[			
Prohibit the use of trawling gear on coral reefs	[			
Require a weak link in the tickler chain of bottom trawls on all habitats	[	[	[	[

Action creating a closure	**Gear Closure**	**Area Closure**
Prohibit bottom anchoring over coral reefs in HAPCs	[	
Prohibit use of all trawling gear, bottom longline, buoy gear, and all traps/pots on coral reefs.		[

Prohibition of bottom trawling over all coral reefs should have significant positive impacts on the small coral areas that are not currently protected through other fishery management protections. However, since *most* areas of coral habitat are already protected from trawling activities, the overall improvement for coral habitat in the Gulf of Mexico would be minimal. Some deepwater areas of coral that are just being identified, such as Pulley Ridge on the southern edge of the West Florida Shelf (Section 3.2.2.2.1), could benefit from such prohibition in the future.

Prohibiting use of all traps, pots, bottom longlines, and buoy gear on coral reefs will have positive impacts on all coral reef habitat. The environmental benefits are described in Section 4.3.2.4, however, it is not possible to quantify all the potential benefits. Coral reef habitat in the EEZ occurs in areas already closed to pots, traps, and longline-buoy gear. However, some coral areas occur outside the closed areas in the vicinity of the Tortugas (which represent about 1,295 ha or approximately 3200 acres) and potentially in areas west of the Tortugas (Pulley Ridge). Thus the areas most likely to be affected occur on the West Florida Shelf.

The combination of actions to prohibit particular gear use on coral habitat, in effect establishes coral reefs as one type of area closure or marine protected area. The only fishing gears that are not listed as prohibited on corals are vertical gears, spears and powerheads. Several existing MPAs within the Gulf of Mexico do allow some use by certain gears, and this alternative would be established in a similar fashion.

Requiring the use of a weak link on tickler chains used with bottom trawls will primarily have positive benefits to hard bottoms that trawls may encounter. The intent is that if the chain were to snag on a piece of hard bottom, the weak link would break and keep the chain and net from dragging and tearing up pieces of bottom life. There would likely still be some damage to hard bottoms, but less than if the chain were sweeping forward over a wide area.

Regulating the amount of weights and sinkers used with vertical gear should have a positive environmental benefit. The action of weights hitting the bottom with each line fished causes damage to biogenic structures, and over time can be relatively significant. Vertical gear is fished over hard bottom more than other types of bottoms, and the relative impacts are highest on this bottom type. Since data are lacking to know how much weight is used on average by fishermen now, and even to know what the complete range of weights used is, there is no way to assess the potential benefit to habitat from this action at this time. This alternative identifies that this needs to be addressed through future action of the Council.

These measures will directly benefit managed and non-managed species of fish and may result in higher productivity if the measures prevent habitat limitation from occurring or lead to improved habitat. These measures may result in population expansion of some fish species harvested from the Gulf of Mexico.

These actions are likely to be neutral and have no impact, positive or negative, on most marine mammals and protected species.

With respect to practicability, this alternative is considered practicable because the environmental benefits, particularly to sensitive habitats, outweighs the potential economic impact directly to fishermen. These actions will have the most positive environmental benefits to coral reefs, and some benefits to hard bottoms, SAV, sand and soft bottoms. Over time, the physical environment and habitats should be expected to recover from past impacts that may have been caused by these gears, if these impacts are reduced or eliminated in the future.

2.3 Alternatives to identify essential fish habitat

The numbering of the following EFH alternatives is based on the numbering of the Concepts for alternatives described in Section 2.1.3.4.1. Because EFH Concepts 3, 7, and 8 were considered but rejected by the Council, the equivalent EFH Alternatives 3, 7, and 8 do not appear among the EFH alternatives listed here.

2.3.1 Red Drum Fishery Management Plan

Red drum, *Sciaenops ocellatus*, is the only species in the FMP.

2.3.1.1 Alternative 1: No action – Roll back

Alternative 1: No EFH would be described and identified for the Red Drum FMP.

This alternative would not describe and identify EFH for the life stages in the Red Drum FMP of the Gulf Council. EFH considerations would be removed from the FMP. Analysis of the No Action alternative is required by NEPA to provide a baseline against which to consider the consequences of the action alternatives. The roll back of EFH would likely receive support from individuals and organizations that wish to simplify regulations and reduce the administrative burden of restrictions on modification of habitat. Conversely, those interests that supported development of the EFH provisions would oppose this alternative. Adoption of this alternative would not meet the requirements of the EFH provisions of the M-S Act and would fail to make the link between habitat and productivity of managed species a more explicit component of the assessment and management process.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 1 does not designate EFH, so those who want EFH described over large areas may object, and vice versa. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.3.1.2 Alternative 2: Status quo

Alternative 2: (Status quo) EFH for the Red Drum FMP consists of areas of common occurrence for red drum in the Gulf of Mexico: virtually all estuarine areas over sand, soft bottom, SAV, emergent marshes, oyster reefs, hard bottoms and pelagic waters continuing to nearshore and offshore habitats to depths of approximately 22 fathoms, as depicted in map Figures 14 and 15, Gulf of Mexico EFH Generic Amendment.

This alternative is based on EFH Concept 2, status quo. Figures 14 and 15 of the Generic EFH Amendment depict the areas of common occurrence (and thus the EFH) of red drum (*Sciaenops ocellatus)* in the Gulf of Mexico. EFH in the estuaries are those areas depicted on the maps as "common", "abundant," and "highly abundant." EFH in the offshore areas are those depicted as adult areas, spawning areas and nursery areas. Table 4 of the Generic Amendment summarizes the habitat associations of the various life stages.

Red drum are distributed over a geographical range from Massachusetts on the Atlantic coast to Tuxpan, Mexico (Simmons and Breuer, 1962). In the Gulf of Mexico red drum occur in a variety of habitats, ranging from depths of about 22 fathoms offshore to very shallow estuarine waters. They commonly occur in virtually all of the Gulf's estuaries (Figure 14, Generic Amendment) where they are found over a variety of substrates including SAV, sand, mud and oyster reefs. Red drum can tolerate salinities ranging from freshwater to highly saline, but optimum salinities for the various life stages have not been determined. Types of habitat occupied depend upon the life stage of the fish. Spawning occurs in deeper water near the mouths of bays and inlets, and on the Gulf side of the barrier islands (Pearson, 1929; Simmons and Breuer, 1962; Perret *et al*., 1980). The eggs hatch mainly in the Gulf, and larvae are transported into the estuary where the fish mature before moving back to the Gulf (Perret *et al*. 1980; Pattillo *et al*., 1997). Adult red drum use estuaries, but tend to spend more time offshore as they age (Figure 15, Generic Amendment). Schools of large red drum are common in Gulf offshore waters.

Alternative 2 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.1.3 Alternative 4: Known distributions of species in the FMUs

Alternative 4: EFH for the Red Drum FMP consists of the Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 22 fathoms, and including all estuaries (Figure 2.3.8)

This alternative is based on EFH Concept 4. Distribution data are available in the NOAA Atlas for juvenile, adult and spawning adult red drum. The NOAA Atlas portrays juvenile distribution as nursery area; adult distribution as adult area[14]; and spawning adult distribution as spawning area. For those life stages not depicted in the NOAA Atlas, information is available on habitats used in terms of substrate type, depth range and eco-regions. This information is provided in Section 3.2.4.1.2 and Appendix C, and was used to identify EFH for these life stages according to the methodology described in Section 2.1.

Figure 2.3.8 provides the composite EFH for the FMP delineated to the 22 fathom isobath, based on this accounting of EFH for all life stages in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.2 and 3.2.3 describe the connections between various habitat types and each life stage in the Red Drum FMU. Section 3.2.4.1.2 states the specific depth ranges at which the Red Drum FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Red Drum FMU.

[14] Adult area is further delineated into commercial and recreational fishing grounds, and recreational fishing grounds, which are located entirely within the adult area.

The region identified as EFH under this alternative for the life stages in the Red Drum FMP presents the largest possible EFH, based on known distribution and habitat utilization.

Alternative 4 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.1.4 Alternative 5: Areas of higher species density, based on the NOAA Atlas only

Alternative 5 EFH for the Red Drum FMP consists of the following Gulf of Mexico estuaries: Mississippi Sound, Chandeleur Sound, Breton Sound, and Lake Ponchartrain; Gulf of Mexico waters and substrates extending from Vermilion Bay, Louisiana to the eastern edge of Mobile Bay, Alabama out to depths of 25 fathoms; Inner Apalachicola Bay estuary out to depths of 5 fathoms; waters and substrates extending from Crystal Beach, Florida to Fort Myers Beach, Florida including Tampa Bay and Charlotte Harbor estuaries out to depths of 5 fathoms (Figure 2.3.8).

This alternative is based on EFH Concept 5. Density information is available in the NOAA Atlas for adult red drum. The NOAA Atlas portrays the distribution of adults in three categories: Adult Area (Year-round); Commercial and Recreational Fishing Ground (Year-round); and Recreational Fishing Ground (Year-round). For other life stages depicted in the atlas there is only one category, therefore it is impossible to distinguish between areas of different density. Of the three categories for adults, the area of highest relative density was assumed to be the area labeled as "commercial and recreational fishing grounds" (at the time of the 1985 NOAA Atlas creation, commercial fishing for red drum was allowed in all states except for Texas). This area is described and identified as EFH under Alternative 5. Figure 2.3.8 shows the area of EFH under Alternative 5, overlaying the area of EFH under Alternative 4. This alternative does not identify EFH for life stages of red drum that does not contain density data in the NOAA Atlas.

Figure 2.3.8 provides the composite EFH for the FMP delineated from Vermilion Bay, Louisiana to the eastern edge of Mobile Bay, Alabama out to depths of 25 fathoms; Inner Apalachicola Bay estuary out to depths of 5 fathoms; waters and substrates extending from Crystal Beach, Florida to Fort Myers Beach, Florida including Tampa Bay and Charlotte Harbor estuaries out to depths of 5 fathoms, and including Mississippi Sound, Chandeleur Sound, Breton Sound, and Lake Ponchartrain, based on this accounting of EFH for all life stages in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.2 and 3.2.3 describe the connections between various habitat types and each life stage in the Red Drum FMU. Section 3.2.4.1.2. states the specific depth ranges at which the Red Drum FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Red Drum FMU.

Alternative 5 designates less EFH than Alternatives 2, 4, and 6, so should result in more support from those favoring narrow designation of EFH, and less support from those favoring broad designation.

2.3.2 Reef Fish Fishery Management Plan

2.3.2.1 Alternative 1: No action – Roll back

Alternative 1 (No action – Roll back) No EFH would be described and identified for the Reef Fish FMP.

This alternative would not describe and identify EFH for the species and life stages in the Reef Fish FMP of the Gulf Council. EFH considerations would be removed from the FMP. Analysis of the No Action alternative is required by NEPA to provide a baseline against which to consider the consequences of the action alternatives. The roll back of EFH would likely receive support from individuals and organizations that wish to simplify regulations and reduce the administrative burden of restrictions on modification of habitat. Conversely, those interests that supported development of the EFH provisions would oppose this alternative. Adoption of this alternative would not meet the requirements of the EFH provisions of the M-S Act and would fail to make the link between habitat and productivity of managed species a more explicit component of the assessment and management process.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 1 does not designate EFH, so those who want EFH described over large areas may object, and vice versa. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.3.2.2 Alternative 2: Status Quo

Alternative 2 EFH for the Reef Fish FMP consists of the combined areas of common occurrence for 11 selected species (red, gag and scamp grouper; red, gray, yellowtail, and lane snapper; greater and lesser amberjack; tilefish; and gray triggerfish) in the Gulf of Mexico: all estuarine and nearshore habitats, and continuing offshore throughout the Gulf to depths of more than 275 fathoms, as depicted in map Figures 16 through 30, Gulf of Mexico EFH Generic Amendment.

This alternative is based on EFH Concept 2, status quo. Figures 16 through 30 of the Generic EFH Amendment depict areas of common occurrence (and thus EFH) of 11 selected species of reef fish (red grouper, *Epinephelus morio*; gag grouper, *Mycteroperca microlepis;* scamp grouper, *Mycteroperca phenax*; red snapper, *Lutjanus campechanus;* gray snapper, *Lutjanus griseus;* yellowtail snapper, *Ocyurus chrysurus;* lane snapper, *Lutjanus synagris*; greater amberjack, *Seriola dumerili;* lesser amberjack, *Seriola fasciata;* tilefish, *Lopholatilus chamaeleonticeps;* and gray triggerfish, *Balistes capriscus*) in the Gulf of Mexico. EFH in the estuaries are those areas depicted on the maps as "common," "abundant," and "highly abundant." EFH in the offshore areas are those depicted as "adult areas," "spawning areas," and "nursery areas." These species were selected because they are considered to be ecologically representative of the other species in the FMU and also because it was reasonably certain that maps of their distribution, as well as habitat association tables, could be completed during the time frame allowed for the preparation of this amendment.

Collectively, the EFH of the selected species ranges from the estuaries to offshore depths of more than 200 m. Juveniles of four of the 11 species (i.e., gag grouper, gray, yellowtail and lane snappers) occupy estuaries to some extent. Tables 5 through 15 of the Generic Amendment show habitat associations for the various life stages of the selected species.

In general, reef fish are widely distributed in the Gulf of Mexico, occupying both pelagic and benthic habitats during their life cycle. A planktonic larval stage lives in the water column and feeds on zooplankton and phytoplankton. Juvenile and adult reef fish are typically demersal and usually associated with bottom topographies on the continental shelf (<100m) which have high relief, i.e., coral reefs, artificial reefs, rocky hard-bottom substrates, ledges and caves, sloping soft-bottom areas, and limestone outcroppings. However, several species are found over sand and soft-bottom substrates. For example, juvenile red snapper are common on mud bottoms in the northern Gulf, particularly off Texas through Alabama. Also, some juvenile snapper such as mutton, gray, red, dog, lane, and yellowtail snappers; and groupers like Goliath, red, gag, and yellowfin groupers have been documented in inshore seagrass beds, mangrove estuaries, lagoons, and larger bay systems (GMFMC, 1981b).

Alternative 2 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.2.3 Alternative 4: Known distributions of species in the FMUs.

<u>Alternative 4</u> EFH for the Reef Fish FMP consists of all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 295 fathoms (Figure 2.3.9).

This alternative is based on EFH Concept 4.

Distribution information is depicted in the NOAA Atlas for ten species in the Reef Fish FMP. EFH is identified in this alternative as the areas depicted as occurrence, adult area, major adult area, recreational fishing ground, commercial fishing ground, spawning area and nursery area according to the following list:

Carangidae—Jacks (1)

Greater amberjack	*Seriola dumerili* – Adult distribution as adult area, commercial fishing ground

Lutjanidae—Snappers (6)

Mutton snapper	*Lutjanus analis*- Adult distribution as occurrence, adult area, recreational fishing ground, commercial fishing ground & Juvenile distribution as nursery area
Red snapper	*Lutjanus campechanus*- Adult distribution as major adult area, adult area, recreational fishing ground, commercial fishing ground & Juvenile distribution as nursery area
Gray (mangrove) snapper	*Lutjanus griseus*- Adult distribution as major adult area, adult area, recreational fishing ground, commercial fishing ground & Juvenile distribution as nursery area
Lane snapper	*Lutjanus synagris*- Adult distribution as adult area, recreational fishing ground, commercial fishing ground & Juvenile distribution as nursery area
Yellowtail snapper	*Ocyurus chrysurus*- Adult distribution as major adult area, adult area, recreational fishing ground, major commercial fishing ground, commercial fishing ground, occurrence & Juvenile distribution as nursery area
Vermilion snapper	*Rhomboplites aurorubens*- Adult distribution as adult area, recreational fishing ground, commercial fishing ground & Juvenile distribution as nursery area

Malacanthidae—Tilefishes (1)

(Golden) Tilefish	*Lopholatilus chamaeleonticeps* – Adult distribution as adult area

Serranidae—Groupers (2)

Black grouper	*Mycteroperca bonaci*- Adult distribution as adult area, commercial fishing ground, occurrence
Red grouper	*Epinephelus morio*- Spawning adult distribution as spawning area & Adult distribution as adult area, major commercial fishing ground, commercial fishing ground, occurrence

For those life stages not depicted in the NOAA Atlas, distribution information is available on the scale of eco-regions. Within eco-regions, information is available on habitats used by substrate

type and depth range. This information is provided in Section 3.2.4.2.2 and Appendix C, and was used to identify EFH for these species and life stages according to the methodology described in Section 2.1. Figure 2.3.9 provides the composite EFH for the FMP, based on this accounting of EFH of individual species and life stages. This alternative uses only distribution data and makes no distinction between all habitats occupied by managed species and their EFH.
Figure 2.3.9 provides the composite EFH for the FMP, delineated to the 295 fathom isobath, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.6 and 3.2.7 describe the connections between various habitat types and each species life stage in the Reef Fish FMU. Section 3.2.4.2.2. states the specific depth ranges at which the Reef Fish FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Reef Fish FMU.

The region identified as EFH under this alternative for the species in the Reef Fish FMP presents the largest possible EFH, based on known distribution and habitat utilization.

Alternative 4 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.2.4 Alternative 5: Areas of higher species density, based on the NOAA Atlas only

Alternative 5. EFH for the Reef Fish FMP consists of all estuaries on Florida's west coast from Tampa Bay southward, exclusive of Old Tampa Bay and Hillsborough Bay; Gulf of Mexico waters and substrates extending from the US/Mexico border to Freeport, Texas between depths of 50 and 100 fathoms; waters extending from Freeport, Texas to Cape San Blas, Florida between depths of 25 and 100 fathoms; waters extending from Cape San Blas, Florida to Clearwater, Florida between depths of 10 and 100 fathoms; waters extending from Clearwater, Florida to the boundary between areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 100 fathoms (Figure 2.3.9).

This alternative is based on EFH Concept 5. Density data are available for adults of nine species under the Reef Fish FMP. This alternative does not identify EFH for species and life stages for which density data are not depicted in the NOAA Atlas. EFH is identified in this alternative as the areas depicted as major adult area, major commercial fishing ground, commercial fishing ground (for species and life stages where "major commercial fishing ground" is not depicted) according to the following list:

Carangidae—Jacks (1)

Greater amberjack *Seriola dumerili*-Adult high density as commercial fishing ground

Lutjanidae—Snappers (6)

Mutton snapper	*Lutjanus analis*- Adult high density as commercial fishing ground
Red snapper	*Lutjanus campechanus*- Adult high density as major adult area
Gray (mangrove) snapper	*Lutjanus griseus*- Adult high density as major adult area
Lane snapper	*Lutjanus synagris*- Adult high density as commercial fishing ground
Yellowtail snapper	*Ocyurus chrysurus*- Adult high density as major adult area, major commercial fishing ground
Vermilion snapper	*Rhomboplites aurorubens*- Adult high density as commercial fishing ground

Serranidae—Groupers (2)

Black grouper	*Mycteroperca bonaci*- Adult high density as commercial fishing ground
Red grouper	*Epinephelus morio*- Adult high density as major commercial fishing ground

Figure 2.3.9 shows the area of EFH under Alternative 5, overlaying the area of EFH under Alternative 4.

Figure 2.3.9 provides the composite EFH for the FMP, delineated from the US/Mexico border to Freeport, Texas between depths of 50 and 100 fathoms; waters extending from Freeport, Texas to Cape San Blas, Florida between depths of 25 and 100 fathoms; waters extending from Cape San Blas, Florida to Clearwater, Florida between depths of 10 and 100 fathoms; waters extending from Clearwater, Florida to the boundary between areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 100 fathoms, and all estuaries on Florida's west coast from Tampa Bay southward, exclusive of Old Tampa Bay and Hillsborough Bay, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.6 and 3.2.7 describe the connections between various habitat types and each species life stage in the Reef Fish FMU. Section 3.2.4.2.2 states the specific depth ranges at which the Reef Fish FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Reef Fish FMU.

Alternative 5 designates less EFH than Alternatives 2, 4, and 6, so should result in more support from those favoring narrow designation of EFH, and less support from those broad designation.

2.3.3 Coastal Migratory Pelagics Fishery Management Plan

2.3.3.1 Alternative 1: No action – Roll back

Alternative 1 (No action – Roll back) No EFH would be described and identified for the Coastal Migratory Pelagics FMP.

This alternative would not describe and identify EFH for the species and life stages in the Coastal Migratory Pelagics FMP of the Gulf Council. EFH considerations would be removed from the FMP. Analysis of the No Action alternative is required by NEPA to provide a baseline against which to consider the consequences of the action alternatives. The roll back of EFH would likely receive support from individuals and organizations that wish to simplify regulations and reduce the administrative burden of restrictions on modification of habitat. Conversely, those interests that supported development of the EFH provisions would oppose this alternative. Adoption of this alternative would not meet the requirements of the EFH provisions of the M-S Act and would fail to make the link between habitat and productivity of managed species a more explicit component of the assessment and management process.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 1 does not designate EFH, so those who want EFH described over large areas may object, and vice versa. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.3.3.2 Alternative 2: Status Quo

Alternative 2 EFH for the Coastal Migratory Pelagics FMP consists of the combined areas of common occurrence for king and Spanish mackerel, cobia and dolphin in the Gulf of Mexico: all estuarine and nearshore habitats continuing offshore throughout the Gulf to depths of approximately 110 fathoms, as depicted in map Figures 31 through 35, Gulf of Mexico EFH Generic Amendment.

This alternative is based on EFH Concept 2, status quo. Figures 31 through 35 of the Generic EFH Amendment depict the areas of common occurrence (and thus the EFH) for four of the six managed species of coastal migratory pelagics (king mackerel, *Scomberomorus cavalla;* Spanish mackerel, *Scomberomorus maculatus;* cobia, *Rachycentron canadum;* and dolphin, *Coryphaena hippurus*) in the Gulf of Mexico. Collectively, these species are commonly distributed from the estuaries (cobia and Spanish mackerel) throughout the marine waters of the entire Gulf of Mexico (i.e., dolphin). Tables 16 through 19 of the Generic Amendment show the habitat associations of the various life stages of king and Spanish mackerel, cobia and dolphin. EFH in the estuaries are those areas depicted on the maps as "common," "abundant," and "highly abundant." EFH in the offshore areas are those depicted as "adult areas," "spawning areas," and "nursery areas."

The occurrence of these four species of coastal migratory pelagics is governed by temperature and salinity (GMFMC and SAFMC, 1985). All four are seldom found in water temperatures less than 20º C. Salinity preference varies, but is generally for high salinity. Dolphin are seldom found in waters with salinity less than 36 ppt. The scombrids prefer high salinities, but less than 36 ppt. Salinity preference of cobia is not well defined. King mackerel seldom venture into brackish waters, although juveniles occasionally use estuaries. Spanish mackerel tolerate brackish to oceanic waters and often inhabit estuaries, which, along with coastal waters, offer year round nursery habitat. The larval habitat of all species in the coastal pelagic management unit is the water column. Within the spawning area, eggs and larvae are concentrated in the surface waters.

Alternative 2 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.3.3 Alternative 4: Known distributions of species in the FMUs.

<u>Alternative 4.</u> EFH for the Coastal Migratory Pelagics FMP consists of all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 110 fathoms (Figure 2.3.10)

This alternative is based on EFH Concept 4. Distribution information is depicted in the NOAA Atlas for three species in the Coastal Migratory Pelagics FMP. EFH is identified in this alternative as the areas depicted as adult area, major adult area, recreational fishing ground, commercial fishing ground, spawning area and nursery area according to the following list:

King mackerel	*Scomberomorus cavalla*- Adult distribution as adult area, recreational fishing ground, commercial fishing ground
Spanish mackerel	*Scomberomorus maculatus*- Spawning adult distribution as spawning area & Adult distribution as adult area, recreational fishing ground, commercial fishing ground
Cobia	*Rachycentron canadum*- Adult distribution as adult area, major adult area & Juvenile distribution as nursery area

For those life stages of these species not depicted in the NOAA Atlas, distribution information is available on the scale of eco-regions. Within eco-regions, information is available on habitats used by substrate type and depth range. This information is provided in Section 3.2.4.3.2 and Appendix C, and was used to identify EFH for these species and life stages according to the methodology described in Section 2.1. Figure 2.3.10 provides the composite EFH for the FMP, based on this accounting of EFH of individual species and life stages. This alternative uses only distribution data and makes no distinction between all habitats occupied by managed species and their EFH.

Figure 2.3.10 provides the composite EFH for the FMP delineated to the 110 fathom isobath, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.13 and 3.2.14 describe the connections between various habitat types and each species life stage in the Coastal Migratory Pelagics FMU. Section 3.2.4.3.2 states the specific depth ranges at which the Coastal Migratory Pelagics FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Coastal Migratory Pelagics FMU.

The region identified as EFH under this alternative for the species in the Coastal Migratory Pelagics FMP presents the largest possible EFH, based on known distribution and habitat utilization.

Alternative 4 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.3.4 Alternative 5: Areas of higher species density, based on the NOAA Atlas only

Alternative 5 EFH for the Coastal Migratory Pelagics FMP consists of the following Gulf of Mexico estuaries: Terrebonne Bay, Timbalier Bay, Bastian Bay, and all estuaries south of the Caloosahatchee River on Florida's west coast; Gulf of Mexico waters and substrates extending from Grand Isle, Louisiana to the tip of the Mississippi River Delta, Louisiana out to depths of 25 fathoms; from Ocean Springs, Mississippi to Cape San Blas, Florida out to depths of 12 fathoms; and from Ft. Myers, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 15 fathoms (Figure 2.3.10).

This alternative is based on EFH Concept 5. Density data are available for adults of all 3 species under the Coastal Migratory Pelagics FMP. This alternative does not identify EFH for life stages for which density data are not depicted in the NOAA Atlas. EFH is identified in this alternative as the areas depicted as major adult area, and commercial fishing ground (for species where "major adult area" is not depicted), according to the following list:

King mackerel	*Scomberomorus cavalla*- Adult high density as commercial fishing ground
Spanish mackerel	*Scomberomorus maculatus*- Adult high density as commercial

	fishing ground
Cobia	*Rachycentron canadum*- Adult high density as major adult area

Figure 2.3.10 shows the composite area of EFH under Alternative 5, overlaying the area of EFH under Alternative 4.

Figure 2.3.10 provides the composite EFH for the FMP delineated from Grand Isle, Louisiana to the tip of the Mississippi River Delta, Louisiana out to depths of 25 fathoms; from Ocean Springs, Mississippi to Cape San Blas, Florida out to depths of 12 fathoms; and from Ft. Myers, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 15 fathoms, and including Terrebonne Bay, Timbalier Bay, Bastian Bay, and all estuaries south of the Caloosahatchee River on Florida's west coast , based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.13 and 3.2.14 describe the connections between various habitat types and each species life stage in the Coastal Migratory Pelagics FMU. Section 3.2.4.3.2 states the specific depth ranges at which the Coastal Migratory Pelagics FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Coastal Migratory Pelagics FMU.

Alternative 5 designates less EFH than Alternatives 2, 4, and 6, so should result in more support from those favoring narrow designation of EFH, and less support from those broad designation.

2.3.4 Shrimp Fishery Management Plan

2.3.4.1 Alternative 1: No action – Roll back

<u>Alternative 1</u> (No action – Roll back) No EFH would be described and identified for the Shrimp FMP.

This alternative would not describe and identify EFH for the species and life stages in the Shrimp FMP of the Gulf Council. EFH considerations would be removed from the FMP. Analysis of the No Action alternative is required by NEPA to provide a baseline against which to consider the consequences of the action alternatives. The roll back of EFH would likely receive support from individuals and organizations that wish to simplify regulations and reduce the administrative burden of restrictions on modification of habitat. Conversely, those interests that supported development of the EFH provisions would oppose this alternative. Adoption of this alternative would not meet the requirements of the EFH provisions of the M-S Act and would fail to make the link between habitat and productivity of managed species a more explicit component of the assessment and management process.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 1 does not designate EFH, so those who want EFH described over large areas may object, and vice versa. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.3.4.2 Alternative 2: Status Quo

Alternative 2 EFH for the Shrimp FMP consists of the combined areas of common occurrence for brown, white, and pink shrimp in the Gulf of Mexico: all estuarine and nearshore habitats continuing offshore throughout the Gulf to depths of approximately 60 fathoms, as depicted in map Figures 8 through 13, Gulf of Mexico EFH Generic Amendment.

Figures 8 through 13 of the Generic EFH Amendment depict the areas of common occurrence (and thus the EFH) of brown, white and pink shrimp in the Gulf of Mexico. EFH in the estuaries are those areas depicted on the maps as “common,” “abundant,” and “highly abundant.” EFH in the offshore areas are those depicted as adult areas, spawning areas and nursery areas. Brown shrimp are found within the estuaries to offshore depths of 60 fathoms throughout the Gulf; white shrimp inhabit estuaries and to depths of about 22 fathoms offshore in the coastal area extending from Florida’s Big Bend area through Texas; pink shrimp inhabit the Gulf coastal area from estuaries to depths of about 36 fathoms offshore and is the dominant species off southern Florida. Brown and white shrimp are generally more abundant in the central and western Gulf, whereas pink shrimp are generally more abundant in the eastern Gulf. Royal red shrimp inhabit terrigeneous and silty sand sediments off the Mississippi and calcareous mud in the Tortugas region, and are most common between depths of 250 to 500m.

Brown, white, and pink shrimp use a variety of habitats as they grow from planktonic larvae to spawning adults (GMFMC, 1981c). Habitat associations for the three species by life stage are summarized in Tables 1, 2 and 3 of the Generic EFH Amendment.

Alternative 2 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.4.3 Alternative 4: Known distributions of species in the FMUs.

Alternative 4 EFH for the Shrimp FMP consists of all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 325 fathoms, excluding hard bottom between 90 and 100 fathoms depth south of Louisiana and Texas and excluding hard bottom deeper than 30 fathoms south of 26ºN off Florida (Figure 2.3.11).

This alternative is based on EFH Concept 4. Distribution information is depicted in the NOAA Atlas for the four species in the Shrimp FMP. EFH is identified in this alternative as the areas depicted as adult area, major adult area, recreational fishing ground, commercial fishing ground, major commercial fishing ground, nursery area and major nursery area according to the following list:

Brown shrimp	*Farfantepenaeus aztecus (Penaeus aztecus)*-Adult distribution as major adult area, adult area, major adult area and commercial fishing ground, major commercial fishing ground, commercial fishing ground & Juvenile distribution as major nursery area, nursery area
White shrimp	*Litopenaeus setiferus (Penaeus setiferus)*- Spawning adult distribution as spawning area & Adult distribution as major adult area, adult area, major adult concentration, commercial fishing ground & Juvenile distribution as nursery area
Pink shrimp	*Farfantepenaeus duorarum (Penaeus duorarum)*- Adult distribution as adult area, major commercial fishing ground, commercial fishing ground & Juvenile distribution as major nursery area, nursery area
Royal red shrimp	*Hymenopenaeus robustus (Pleoticus robustus)*- Adult distribution as major adult area, adult area

For those life stages not depicted in the NOAA Atlas, distribution information is available on the scale of eco-regions. Within eco-regions, information is available on habitats used by substrate type and depth range. This information is provided in Section 3.2.4.4.2 and Appendix C, and was used to identify EFH for these species and life stages according to the methodology described in Section 2.1. Figure 2.3.11 provides the composite EFH for the FMP, based on this accounting of EFH of individual species and life stages. This alternative uses only distribution data and makes no distinction between all habitats occupied by managed species and their EFH.

Figure 2.3.11 provides the composite EFH for the FMP delineated from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 325 fathoms, excluding hard bottom between 90 and 100 fathoms depth south of Louisiana and Texas and excluding hard bottom deeper than 30 fathoms south of 26ºN off Florida, including all Gulf of Mexico estuaries, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.17 and 3.2.18 describe the connections between various habitat types and each species life stage in the Shrimp FMU. Section 3.2.4.4.2 states the specific depth ranges at which the Shrimp FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Shrimp FMU.

Alternative 4 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.4.4 Alternative 5: Areas of higher species density, based on the NOAA Atlas only

Alternative 5 EFH for the Shrimp FMP consists of all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from the US/Mexico border to eastern Mobile Bay, Alabama out to depths of 60 fathoms; from eastern Mobile Bay to Steinhatchee, Florida between depths of 10 and 25 fathoms; from Steinhatchee, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council to depths of 5 fathoms; from Charlotte Harbor to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council between depths of 10 and 30 fathoms; an area in the US EEZ north of Cuba from Puerto Esperanza to Bahia de Habana between depths of 100 and 325 fathoms; and from Grand Isle to Pensacola Bay between depths of 100 and 325 fathoms (Figure 2.3.11).

This alternative is based on EFH Concept 5. Density data are available in the NOAA Atlas for adults of all species of shrimp in the FMP, and juveniles of brown and pink shrimp. This alternative does not identify EFH for species and life stages for which density data are not depicted in the NOAA Atlas. EFH is identified in this alternative as the areas depicted as major adult area and commercial fishing ground, major adult area, major commercial fishing ground, major adult concentration and major nursery area according to the following list:

Brown shrimp	*Farfantepenaeus aztecus (Penaeus aztecus)*- Adult distribution as major adult area, major adult area and commercial fishing ground, major commercial fishing ground, & Juvenile distribution as major nursery area
White shrimp	*Litopenaeus setiferus (Penaeus setiferus)*- Adult distribution as major adult area, major adult concentration

Pink shrimp	*Farfantepenaeus duorarum (Penaeus duorarum)*- Adult distribution as major commercial fishing ground and juvenile distribution as major nursery area
Royal red shrimp	*Hymenopenaeus robustus (Pleoticus robustus)*- Adult distribution as major adult area

Figure 2.3.11 shows the area of EFH under Alternative 5, overlaying the area of EFH under Alternative 4.

Figure 2.3.11 provides the composite EFH for the FMP delineated from the US/Mexico border to eastern Mobile Bay, Alabama out to depths of 60 fathoms; from eastern Mobile Bay to Steinhatchee, Florida between depths of 10 and 25 fathoms; from Steinhatchee, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council to depths of 5 fathoms; from Charlotte Harbor to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council between depths of 10 and 30 fathoms; an area in the US EEZ north of Cuba from Puerto Esperanza to Bahia de Habana between depths of 100 and 325 fathoms; and from Grand Isle to Pensacola Bay between depths of 100 and 325 fathoms, including all Gulf of Mexico estuaries, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.17 and 3.2.18 describe the connections between various habitat types and each species life stage in the Shrimp FMU. Section 3.2.4.4.2 states the specific depth ranges at which the Shrimp FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Shrimp FMU.

Alternative 5 designates less EFH than Alternatives 2, 4, and 6, so should result in more support from those favoring narrow designation of EFH, and less support from those broad designation.

2.3.5 Stone Crab Fishery Management Plan

2.3.5.1 Alternative 1: No action – Roll back

<u>Alternative 1</u> (No action – Roll back) No EFH would be described and identified for the Stone Crab FMP.

This alternative would not describe and identify EFH for the species and life stages in the Stone Crab FMP of the Gulf Council. EFH considerations would be removed from the FMP. Analysis of the No Action alternative is required by NEPA to provide a baseline against which to consider the consequences of the action alternatives. The roll back of EFH would likely receive support from individuals and organizations that wish to simplify regulations and reduce the administrative burden of restrictions on modification of habitat. Conversely, those interests that supported development of the EFH provisions would oppose this alternative. Adoption of this alternative would not meet the requirements of the EFH provisions of the M-S Act and would fail to make the link between habitat and productivity of managed species a more explicit component of the assessment and management process.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 1 does not designate EFH, so those who want EFH described over large areas may object, and vice versa. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.3.5.2 Alternative 2: Status Quo

Alternative 2 EFH for the Stone Crab FMP consists of areas of common occurrence for the stone crab *Menippe mercenaria* throughout the Gulf of Mexico: all estuarine and nearshore habitats continuing offshore to approximate depths of 30 fathoms, as depicted in map Figures 36 and 37, Gulf of Mexico EFH Generic Amendment.

This alternative is based on EFH Concept 2, status quo. Figure 36 of the Generic Amendment depicts areas of common occurrence of the stone crab in the Gulf of Mexico, while Figure 37 shows offshore occurrence. Although the Generic Amendment recognized that *Mercenaria adina* largely replaces *M. mercenaria* west of Cedar Key, only *M. mercenaria* was considered, as the fishery is virtually all for that species. Table 19 of the Generic Amendment shows habitat associations of the various life stages of *M. mercenaria*.

Adults inhabit rock ledges, coral heads, dead shell, grass clumps, burrows in seagrass beds and tidal channels. Juveniles use shell bottom, sponges, *Sargassum* mats, channels, and grass flats, and oyster reefs. Larvae are planktonic and drift with currents. Eggs occur in the same habitats as adults.

Alternative 2 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.5.3 Alternative 4: Known distributions of species in the FMUs.

Alternative 4 EFH for the Stone Crab FMP consists of all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 30 fathoms (Figure 2.3.12)

This alternative is based on EFH Concept 4. Distribution information is depicted in the NOAA Atlas for Stone Crab. The atlas map shows stone crab as a single species, but stone crabs in the Gulf are now considered to be of two separate species. The distribution of the two species is either side of a zone of overlap between Cedar Key and Cape San Blas, Florida. Gulf stone crab occur north and west of this zone, and stone crab occur south of this zone. The atlas map was interpreted using this information. EFH is identified in this alternative as the areas depicted as adult area, major adult area, commercial fishing ground, and nursery area according to the following list:

Stone Crab	*Menippe mercenaria*- Adult distribution as major adult area, adult area, commercial fishing ground & Juvenile distribution as nursery area
Gulf Stone Crab	*Menippe adina*- Adult distribution as major adult area, adult area, commercial fishing ground & Juvenile distribution as nursery area

For those life stages not depicted in the NOAA Atlas, distribution information is available on the scale of eco-regions. Within eco-regions, information is available on habitats used by substrate type and depth range. This information is provided in Section 3.2.4.5.2 and Appendix C, and was used to identify EFH for these species and life stages according to the methodology described in Section 2.1. Figure 2.3.12 provides the composite EFH for the FMP, based on this accounting of EFH of individual species and life stages. This alternative uses only distribution data and makes no distinction between all habitats occupied by managed species and their EFH.

Figure 2.3.12 provides the composite EFH for the FMP delineated to the 30 fathom isobath, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.21 and 3.2.22 describe the connections between various habitat types and each species life stage in the Stone Crab FMU. Section 3.2.4.5.2 states the specific depth ranges at which the Stone Crab FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Stone Crab FMU.

The region identified as EFH under this alternative for the species in the Stone Crab FMP presents the largest possible EFH, based on known distribution and habitat utilization.

Alternative 4 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.5.4 Alternative 5: Areas of higher species density, based on the NOAA Atlas only

Alternative 5 EFH for the Stone Crab FMP consists of all Gulf of Mexico estuaries from Charlotte Harbor southward on Florida's west coast; Gulf of Mexico waters and substrates extending from northern Charlotte Harbor to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 25 fathoms (Figure 2.3.12)

This alternative is based on EFH Concept 5. Density data are available for adult stone crab. This alternative does not identify EFH for species and life stages for which density data are not depicted in the NOAA Atlas. EFH is identified in this alternative as the areas depicted as major adult area of stone crab, *Menippe mercenaria*. Figure 2.3.12 shows the area of EFH under Alternative 5, overlaying the area of EFH under Alternative 4.

Figure 2.3.12 provides the composite EFH for the FMP delineated from northern Charlotte Harbor to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 25 fathoms, and including all Gulf of Mexico estuaries from Charlotte Harbor southward on Florida's west coast, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.21 and 3.2.22 describe the connections between various habitat types and each species life stage in the Stone Crab FMU. Section 3.2.4.5.2 states the specific depth ranges at which the Stone Crab FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Stone Crab FMU.

Alternative 5 designates less EFH than Alternatives 2, 4, and 6, so should result in more support from those favoring narrow designation of EFH, and less support from those broad designation.

2.3.6 Spiny Lobster Fishery Management Plan

2.3.6.1 Alternative 1: No action – Roll back

Alternative 1 (No action – Roll back) No EFH would be described and identified for the Spiny Lobster FMP.

This alternative would not describe and identify EFH for the species and life stages in the Spiny Lobster FMP of the Gulf Council. EFH considerations would be removed from the FMP. Analysis of the No Action alternative is required by NEPA to provide a baseline against which to consider the consequences of the action alternatives. The roll back of EFH would likely receive support from individuals and organizations that wish to simplify regulations and reduce the administrative burden of restrictions on modification of habitat. Conversely, those interests that supported development of the EFH provisions would oppose this alternative. Adoption of this alternative would not meet the requirements of the EFH provisions of the M-S Act and would fail to make the link between habitat and productivity of managed species a more explicit component of the assessment and management process.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 1 does not designate EFH, so those who want EFH described over large areas may object, and vice versa. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.3.6.2 Alternative 2: Status Quo

Alternative 2 EFH for Spiny Lobster FMP consists of areas of common occurrence for spiny lobster *Panulirus argus,* in the Gulf of Mexico*:* all estuarine and nearshore habitats continuing offshore to approximate depths of 44 fathoms from the Florida Keys north to approximately Tarpon Springs, FL, as depicted in map Figures 38 and 39, Gulf of Mexico EFH Generic Amendment.

This alternative is based on EFH Concept 2, status quo. Figures 38 and 39 of the Generic EFH Amendment depict areas of common occurrence for spiny lobster in the Gulf of Mexico. The principal habitat for adults is offshore reefs and seagrasses in the southeastern Gulf. Juveniles inhabit habitats providing refugia such as sponges, small coral heads, sea urchins seagrass, and macroalgae. Pueruli require vegetated habitats for development. Phyllosoma larvae are epipelagic throughout the Gulf, and eggs occur in the same habitats as adults.

Alternative 2 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.6.3 Alternative 4: Known distributions of species in the FMUs

Alternative 4. EFH for the Spiny Lobster FMP consists of the Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from the shoreline to the 100 fathom contour, excluding estuaries west of Cedar Key, Florida and excluding hard bottom south of 27ºN deeper than 100 fathoms (Figure 2.3.13).

This alternative is based on EFH Concept 4. Distribution information is depicted in the NOAA Atlas for spiny lobster *Panulirus argus* adults and juveniles. EFH is identified in this alternative as the areas depicted as rare occurrence, occurrence, commercial fishing ground, and nursery area.

For those species (i.e. slipper lobster) and life stages not depicted in the NOAA Atlas, distribution information is available on the scale of eco-regions. Within eco-regions, information is available on habitats used by substrate type and depth range. This information is provided in Section 3.2.4.6.2 and Appendix C, and was used to identify EFH for these species and life stages according to the methodology described in Section 2.1. Figure 2.3.13 provides the composite EFH for the FMP, based on this accounting of EFH of individual species and life stages. This alternative uses only distribution data and makes no distinction between all habitats occupied by managed species and their EFH.

Figure 2.3.13 provides the composite EFH for the FMP delineated from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from the shoreline to the 100 fathom contour, excluding estuaries west of Cedar Key, Florida and excluding hard bottom south of 27ºN deeper than 100 fathoms, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.25 and 3.2.26 describe the connections between various habitat types and each species life stage in the Spiny Lobster FMU. Section 3.2.4.6.2 states the specific depth ranges at which the Spiny Lobster FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Spiny Lobster FMU.

The region identified as EFH under this alternative for the species in the Spiny Lobster FMP presents the largest possible EFH, based on known distribution and habitat utilization.

Alternative 4 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.6.4 Alternative 5: Areas of higher species density, based on the NOAA Atlas only

<u>Alternative 5.</u> EFH for the Spiny Lobster FMP consists of Gulf of Mexico waters and substrates extending from Long Key, Florida to the Dry Tortugas out to depths of 25 fathoms (Figure 2.3.13)

This alternative is based on EFH Concept 5. Density data are available for spiny lobster adults. This alternative does not identify EFH for species and life stages for which density data are not depicted in the NOAA Atlas. EFH is identified in this alternative as the areas depicted as commercial fishing ground. Figure 2.3.13 shows the area of EFH under Alternative 5, overlaying the area of EFH under Alternative 4.

Figure 2.3.13 provides the composite EFH for the FMP delineated from Long Key, Florida to the Dry Tortugas out to depths of 25 fathoms, based on this accounting of EFH for all the life stages of species in the FMU.

Figure 3.1.3 depicts Gulf of Mexico Sediments, Habitat Types, and Depths that further define the habitats described as EFH. The habitat association tables 3.2.25 and 3.2.26 describe the connections between various habitat types and each species life stage in the Spiny Lobster FMU. Section 3.2.4.6.2 states the specific depth ranges at which the Spiny Lobster FMU species occur. The combination of these figures, text descriptions, and tables describes and identifies EFH for all species and life stages in the Spiny Lobster FMU.

Alternative 5 designates less EFH than Alternatives 2, 4, and 6, so should result in more support from those favoring narrow designation of EFH, and less support from those broad designation.

2.3.7 Coral Reef Fishery Management Plan

2.3.7.1 Alternative 1: No action – Roll back

Alternative 1 (No action – Roll back) No EFH would be described and identified for the Coral Reef FMP.

This alternative would not describe and identify EFH for the species and life stages in the Coral Reef FMP of the Gulf Council. EFH considerations would be removed from the FMP. Analysis of the No Action alternative is required by NEPA to provide a baseline against which to consider the consequences of the action alternatives. The roll back of EFH would likely receive support from individuals and organizations that wish to simplify regulations and reduce the administrative burden of restrictions on modification of habitat. Conversely, those interests that supported development of the EFH provisions would oppose this alternative. Adoption of this alternative would not meet the requirements of the EFH provisions of the M-S Act and would fail to make the link between habitat and productivity of managed species a more explicit component of the assessment and management process.

Designation of EFH has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 1 does not designate EFH, so those who want EFH described over large areas may object, and vice versa. Designation of EFH will result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.2.

2.3.7.2 Alternative 2: Status Quo

Alternative 2 EFH for the Coral Reef FMP in the Gulf of Mexico consists of: coral reef communities or solitary specimens occurring from nearshore environments to continental slopes and canyons, including the intermediate shelf zones, and primary areas of coral concentration in the East and West Flower Garden Banks and Florida Middle Grounds, as depicted in map Figure 40, Gulf of Mexico EFH Generic Amendment.

This alternative is based on EFH Concept 2, status quo. Figure 40 depicts areas of common occurrence for coral in the Gulf of Mexico. The principal habitats for coral are known coral reefs and scattered coral heads, banks, pinnacles or hard bottoms. Primary coral concentrations or reefs described included the East and West Flower Garden Banks and the Florida Middle Grounds. The Gulf of Mexico EFH Generic Amendment did not describe primary coral concentrations or reefs found in the Florida Reef Tract, and identified these areas as described in the South Atlantic Council's EFH amendment. The other areas primarily lie along the offshore banks and shelf edge (approximately 55 – 220 m depth) from Texas to north Florida, and in a wide area of hard bottom in the nearshore and offshore areas off the central to southwest Florida Coast and around the Florida Keys and outlying islands.

Alternative 2 provides for a wide designation of EFH, and incorporates a wide expanse of the Gulf of Mexico. This alternative would likely generate nearly an opposite response from Alternative 1, receiving support from those interests seeking the widest possible mandate for consultations, and opposition from those objecting to restrictions on modification of habitat.

2.3.7.3 Alternative 5: Areas of higher species density, based on the NOAA Atlas only

This alternative is based on EFH Concept 5. The NOAA Atlas depicts coral and hard bottom habitats but does not specifically identify density related data for coral. EFH for the Coral FMP cannot therefore be developed in the Gulf of Mexico under the alternative. There is a lack of density-oriented information for coral life stages.

2.3.7.4 Alternative 6: Areas of higher species density, based on the NOAA Atlas and functional relationships analysis

Alternative 6 EFH for the Coral FMP is living coral in the Flower Gardens and Tortugas Ecological Reserve (Figure 2.3.7).

This alternative is based on EFH Concept 6, areas of highest density, and uses data from the functional relationship database. These data indicate that the Flower Gardens and the Tortugas Ecological Reserve contain the only substantial concentrations of living coral reef in the Gulf of Mexico. As a result, these areas are considered as the highest coral densities. Alternative 6 designates EFH at a level intermediate between those of Alternative 1 and Alternatives 2 and 4, so should result in an intermediate level of controversy.

2.4 Alternatives for identifying HAPC

The numbering of the following HAPC alternatives is associated with the numbering of the "Concepts" for alternatives described in Section 2.1.3.4.1. Because HAPC Concepts 5 and 6 were considered but rejected by the Council, HAPC Alternatives 5 and 6 do not appear among the HAPC alternatives listed here.

2.4.1 Alternative 1 (No Action – roll back) Do not establish any habitat areas of particular concern (HAPCs) under the EFH Amendment

Under this alternative, the HAPC established under the Generic EFH Amendment would be rescinded. No HAPC, other than those established prior to the Generic Amendment, would occur. NOAA Fisheries encourages, but does not require, HAPC. Therefore, no additional conservation attention would focus on habitat beyond that of the EFH provisions.

Note that if any of the EFH alternatives under Concepts 2-6 are chosen for any FMP, the Council could still decide not to designate HAPCs and, if so, the consequences of the HAPC no action alternative would be the same as for those EFH alternatives. Even if the Council chooses not to identify or establish HAPCs, it could establish HAPCs subsequently through an FMP amendment.

The Gulf Council designated the Flower Garden Banks and the Florida Middle Grounds as HAPCs under the Coral FMP (August 1984) prior to the 1998 Generic Amendment, however, these are not currently HAPCs under the EFH provisions. If this alternative were chosen, there would be no designation of HAPCs under the EFH provisions. No specific impacts can be attributed to this alternative, but none of the potential benefits of HAPC designation would be realized. Finally, under the No Action alternative, no HAPCs can be mapped.

Similar to EFH, designation of HAPC has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 1 does not designate HAPC, so should result in opposition from those who want increased numbers or sizes of HAPC, and vice versa. Designation of HAPC will result in indirect impacts due to two other provisions of the M-S Act. First, increased conservation scrutiny may occur when addressing adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, increased conservation scrutiny may occur when addressing Federal agency actions that may EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act.

2.4.2 Alternative 2 (Status quo) HAPC are those general habitat types and specific sites that are listed in the 1998 Generic EFH Amendment; no additional HAPCs are identified .

This alternative would result in no new action (status quo). In the 1998 Generic Amendment, the Gulf Council identified general types of HAPCs and specific HAPCs based on the four considerations described in the Final Rule (see Section 2.1.4). Under this alternative no additional HAPCs would be identified or established at this time. It is important to remember that while HAPCs are not required, they are highly recommended. With this in mind, however, the general HAPCs identified in the Generic Amendment appear to be much broader than the intent of the guidelines in the EFH Final Rule (published since the completion of the Generic Amendment). The Final Rule encourages more discreet use of HAPCs as a tool to single out priority areas for conservation and management. NOAA Fisheries encourages Councils to designate HAPCs as localized areas that are especially vulnerable or ecologically important.

General HAPCs that were identified in the 1998 Generic Amendment include:

1. Nearshore areas of intertidal and estuarine habitats with emergent and submerged vegetation, sand and mud flats, shell and oyster reefs, and other substrates that may provide food and rearing for juvenile fish and shellfish; and areas sensitive to natural or human-induced environmental degradation or developmental activities. These areas were considered unique, rare, some limited in areal scope compared to other marine habitats, and under the most intense development pressure.

2. Offshore areas with substrates of high habitat value and diversity or vertical relief that serve as cover for fish and shellfish. These were identified as areas with rich epifaunal communities (e.g., coral, anemones, bryozoans, etc.) or various types of liverock and other hard bottom. Fishing activities may most readily impact complex habitat structures.

3. Marine and estuarine habitat used for migration, spawning, and rearing of fish and shellfish, especially in urban areas and in other areas adjacent to intensive human-induced developmental activities.

Specific HAPCs were identified as existing national marine sanctuaries (NMS), national estuarine research reserves (NERR), and several other specific sites, including: Florida Keys NMS; Florida Bay; Flower Gardens NMS; Apalachicola NERR; Rookery Bay NERR; Weeks Bay NERR; Grand Bay NERR, MS; Florida Middle Grounds; and Dry Tortugas (Ft. Jefferson National Park).

Many of the specific areas identified in the Generic Amendment (the NMSs and NERRs) were not necessarily designated under their respective programs based on their importance as habitat for managed species. The criteria used may have been very different from the conditions specified in the EFH Final Rule for establishing HAPCs. Sites previously designated on the basis of criteria other than these conditions might not meet the requirements of the EFH Final Rule. However, during the Generic Amendment process, the Gulf Council determined that sufficient information was developed for these areas to document their value as HAPCs. These specific justifications are provided in Section 7.3 of the Generic EFH Amendment.

Similar to EFH, designation of HAPC has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 2 designates a relatively large amount of HAPC, so should result in support from those who want increased numbers or sizes of HAPC, and vice versa. Designation of HAPC will result in indirect impacts due to two other provisions of the M-S Act. First, increased conservation scrutiny may occur when addressing adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, increased conservation scrutiny may occur when addressing Federal agency actions that may EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act.

2.4.3 Alternative 3: HAPCs would consist of selected existing Federally-managed marine areas including two National Marine Sanctuaries, four National Estuarine Research Reserves, 31 National Wildlife Refuges, seven National Marine Fisheries Service Critical Habitat Areas Fisheries Management Zones, and three National Park Systems.

These are listed in Table 2.4.2.

Federal agencies, including NOAA Fisheries and the Gulf Council, have designated marine and estuarine sites as parks, refuges, or other managed areas around the Gulf. Under the national Marine Protected Areas Project, the National Ocean Service has identified these sites, consolidated their data into one database, and produced maps available at www.mpa.gov (Figures 2.3.14 a-d and 2.3.15 a-e) (NOAA 2003c). Table 2.4.2 identifies the site purpose, fishery resources habitat resources, and activities not allowed, where this information was available.

All of these sites are located in areas having high ecological importance for one or more Federally managed species, as described in Section 3.2.4, and may have rules restricting fishing and non-fishing activities. Ecological importance is one of the four considerations for HAPCs. Several sites, such as the East and West Flower Garden Banks, Florida Middle Grounds, and Tortugas Ecological Reserves (not on Figure 2.3.15 e), contain coral reef, other coral resources and hard bottom, which are rare. These and other sites also have high sensitivity to fishing and/or non-fishing activities, other considerations for HAPC designation.

Available data for the National Wildlife Refuges (NWRs) was not complete; however, ten of these sites (Moody, Sabine, Shell Keys, Breton, St. Marks, Lower Suwannee, Cedar Keys, Chassahowitzka, Crystal River, and Matlacha Pass NWRs) include specific habitats identified in Alternative 8 as rare and stressed from current development, two other considerations for HAPCs.

The protected areas established by the Gulf Council (i.e. National Marine Fisheries Service Critical Habitat Areas Fisheries Management Zones) for habitat and fishery resources in the past are described in detail in Section 3.5.1. In 1984, under the Coral FMP, the Gulf Council designated three HAPCs, the Florida Middle Grounds and the West and East Flower Garden

Banks. The Flower Garden Banks HAPCs were subsequently made a marine sanctuary by NOS. Since these designations were made prior to the 1996 reauthorization of the M-S Act, these sites should be re-designated as HAPCs under the new EFH guidelines. The other Gulf Council management areas are included on this list, but may not meet the other recommended HAPC considerations.

Selecting HAPC from among these sites has the advantage of existing administrative and management arrangements, which will provide certain additional habitat benefits. The EFH Final Rule requires that HAPCs be mapped. The selected Federally designated marine and estuarine managed areas have been mapped (See Section 3.5.1).

Similar to EFH, designation of HAPC has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 3 designates existing managed areas as HAPC, which should reduce controversy. Designation of HAPC will result in indirect impacts due to two other provisions of the M-S Act. First, increased conservation scrutiny may occur when addressing adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, increased conservation scrutiny may occur when addressing Federal agency actions that may EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act.

2.4.4 Alternative 4: Identify and establish habitat areas of particular concern as those habitat areas used for spawning aggregations of managed reef fish species that are most in need of protection.

This alternative was designed to establish specific, known and suspected, important spawning grounds of certain reef fish species as HAPC. Under this alternative, the process of spawning and specific spawning sites could be considered most in need of protection to maintain the overall productivity of these identified species, and these sites would receive HAPC designation.

Nassau grouper, goliath grouper, and yellowfin grouper are known to form spawning aggregations (Olsen and La Place 1978; Beets and Friedlander 1992: Domeier and Colin 1997). Rock hind and Warsaw grouper are suspected to aggregate for spawning (NOAA 2000; Gilmore, personal communication). The Council has established two MPAs that encompass spawning areas for gag (Madison-Swanson and Steamboat Lumps) and established a seasonal closure of the mutton snapper spawning ground (Riley's Hump in the Dry Tortugas). A MPA was subsequently established to include the Riley's Hump site.

Under this HAPC Alternative, additional sites described and discussed in the "Regulatory Amendment to the Reef Fish Fishery Management Plan to Set 1999 Gag/Black grouper Management Measures (revised)" (GMFMC 1999) could also be considered HAPC. Dr. Chris Koenig (FSU) and Chris Gledhill (NOAA Fisheries) identified these offshore sites, located at depths between 20-50 fathoms and consisting of high relief and low relief reefs and hard bottom, as currently or historically in use by snappers and groupers as spawning habitat or adult aggregation sites. For some sites, Dr. Koenig concluded that fishing pressure had reduced abundance to low levels, thus protection as HAPC could potentially add a level of protection not already established.

The sites identified and described by Drs. Koenig and Gledhill which could be considered as HAPC are presented in Figure 2.3.16. These sites are known as: 29 Edge/27 Edge, "Woodward-Clyde" Pinnacles, 3-to-5s, Area north of Johnny Walker site, Madison and Swanson sites, Twin Ridges, Middle Grounds, 40 Fathom Contour west of the Middle Grounds, Steamboat Lumps, Elbo, Christmas Ridge, Hambone Ridge/The Finger, Northwest Peaks, and Riley's Hump. The latitude and longitude of the boundaries of each site, full site descriptions, and the corresponding USGS lease block numbers for each of these sites are provided in great detail in the 1999 Reef Fish regulatory amendment (GMFMC 1999).

Other sites could also be added, if they are shown to be prime aggregation sites for spawning, which would meet criterion (a) having "important ecological function." By establishing these sites believed to be critical to the spawning needs of these managed reef fish species as HAPC, all activities that posed threats to these areas would receive the highest level of scrutiny possible by both the NOAA Fisheries and the Gulf Council.

2.4.5 Alternative 8. HAPCs are identified as habitat parcels that meet one or more of the considerations set out in the EFH Final Rule (50 CFR, Part 600).

Under this alternative, parcels of EFH are identified as HAPCs as a result of one or more of the four considerations set out in the EFH Final Rule (50 CFR, Part 600). The quantitative metrics and analytical processes used for the four considerations are described in Sections 2.1.4.2 and 2.1.4.3. The results of these analyses are described in Sections 3.2.4 (ecological importance), 3.5.2 (fishing sensitivity), 3.5.5 (non-fishing sensitivity and stress from development activities) and 3.2.3.2 (habitat rarity). The maps prepared from these results indicate a number of candidate areas for HAPC. The habitat parcels identified as possible HAPCs and the habitat considerations that apply in each case are shown in the text table below. Where possible, the table also indicates which FMP would be most appropriate for designating the HAPC. Where it is not clear which FMP would be the most appropriate, it is left blank.

Proposed HAPC Site	The importance of the ecological function provided by the habitat	The sensitivity of the habitat to human-induced environmental degradation		Whether and to what extent development activities are, or will be, stressing the habitat type	The rarity of the habitat type	Suggested FMP for designation
		Fishing activities	non-fishing activities			
The Flower Gardens (Section 3.2.2.1, Figure 3.3.1)	**X**	**X**		**No Data**	**X**	Coral FMP

Proposed HAPC Site	The importance of the ecological function provided by the habitat	The sensitivity of the habitat to human-induced environmental degradation		Whether and to what extent development activities are, or will be, stressing the habitat type	The rarity of the habitat type	Suggested FMP for designation
		Fishing activities	non-fishing activities			
Dry Tortugas National Park (Section 3.2.2.1, Figure 3.3.1)	**X**	**X**	**X**		**X**	Coral FMP
Tortugas Ecological Reserve (Section 3.2.2.1, Figure 3.3.1)	**X**	**X**	**X**		**X**	Coral FMP
South Texas Banks (Section 3.2.2.2.6)	**X**	**X**			**X**	Reef Fish FMP
Texas-Louisiana Shelf Break Topographic Features (Section 3.2.2.2.3)	**X**	**X** (oil and gas)			**X**	Reef Fish FMP
Mississippi-Alabama Pinnacle Trend (Section 3.2.2.2.2)	**X**	**X**			**X**	Reef Fish FMP
Florida Middle Grounds (Section 3.2.2.2.1)	**X**	**X**			**X**	Reef Fish FMP
Seagrass areas of the Florida Keys (Section 3.2.1.1)	**X**	**X**	**X**			Shrimp FMP
Seagrass areas of the Florida Big Bend (Section 3.2.1.1)	**X**	**X**	**X**			Reef Fish FMP
Galveston Bay, West Bay and East Bay (Section 3.2.1.3)	**X**			**X**	**X** (sand and mangrove)	Shrimp FMP
Southwest Louisiana marshes				**X**		
Oyster beds of Vermilion Bay				**X**		

Proposed HAPC Site	The importance of the ecological function provided by the habitat	The sensitivity of the habitat to human-induced environmental degradation		Whether and to what extent development activities are, or will be, stressing the habitat type	The rarity of the habitat type	Suggested FMP for designation
		Fishing activities	non-fishing activities			
Marsh, mangrove, oyster bed and sand areas of Terrebonne Bay, Caminada Bay and Barataria Bay				**X**	**X**	
Oyster beds of Breton Sound and Chandeleur Sound					**X**	
Chandeleur Islands (mangroves)					**X**	
Silt areas of Breton Sound and off Biloxi/Gulfport					**X**	
Oyster Beds in Mobile Bay (Section 3.2.1.6)					**X**	
Oyster beds in upper Tampa Bay (Section 3.2.1.6)					**X**	
Oyster Beds at the mouth of the Caloosahatchee River (Section 3.2.1.6)					**X**	
Sargassum (Section 3.2.2.5)					**X**	Reef Fish FMP
Sand in Whitewater Bay, South Florida					**X**	

The implementation of the conditions shown in the HAPC decision tree (see Section 2.1.4.3) are described below.

1. High habitat use index for any FMP. The maps of habitat use for the FMPs (Figures 3.2.3 to 3.2.8) show that nearly the entire Gulf of Mexico from the shoreline to the 1,000-fathom isobath has a high habitat use (index of 1) for at least one of the FMPs. Under each FMP, the areas with the highest habitat use were also relatively large, and not really appropriate to be identified as HAPCs ("HAPCs are localized areas that are especially vulnerable or ecologically important" 50

CFR, Part 600 2357). This suggests that the metric used to quantify ecological importance (habitat use) is not evaluated at a sufficiently fine scale to be useful in the identification of HAPCs. Most of the HAPCs that are identified under the other considerations, however, also meet the condition of high ecological importance according to the measure of habitat use.

2. High fishing sensitivity index (Figure 2.3.17). Habitat parcels with the two highest levels of the fishing sensitivity index (scale of 1 or 2) were selected as candidates for HAPCs. For the most part this identified small areas of coral habitats (Section 3.2.2.1) and hard bottom (Sections 3.2.1.4 and 3.2.2.2). These are listed in the table above and illustrated in Figure 2.3.17. A large area of the west Florida shelf, which is classified as hard bottom, was also identified on the map, however, this was considered to be too large to be an HAPC. In fact, the resolution of the habitat classification in this area is poor. While this entire large parcel is identified as hard bottom, it is only certain patches that are actually hard bottom, interspersed with other soft bottoms. The precise locations of the hard bottom patches are not known.

3. High non-fishing sensitivity index (Figure 2.3.18). The areas with the two highest levels non-fishing sensitivity (scale of 1or 2) are coral and seagrass in the eastern Gulf (see table above). The Flower Gardens, a coral area in the western Gulf are in the off shore zone, which was not included in the analysis of sensitivity to non-fishing activities. This area is, however, identified as an HAPC under other considerations.

4. High habitat stress index (Figure 2.3.19). None of the areas of the eastern Gulf of Mexico were classified as having a high stress index (Figure 2.3.19b). In fact, nearly all of the least stressed areas (scale of 10) occur in this region. High non-fishing stress within the two highest levels of the index (scale of 1 and 2) occurs in eco-region 4 (Figure 2.3.19a). Important stressed areas are Galveston Bay and the marshes of Louisiana (see table above).

5. High rarity index (Figure 2.3.20). Difficulties with the interpretation of the rarity index are discussed in Section 3.2.3.2. Several different types of habitat were identified as being rare in all five of the eco-regions (see Section 3.2.3.2). All of these are listed as potential HAPCs in the table above, with the exception of the large area of hard bottom in eco-region 2. Even though this was identified by the analysis as being rare, it was not considered to be an appropriate size for an HAPC. The problems with the resolution of the habitat classification in this area described above also apply here.

Similar to EFH, designation of HAPC has no direct impact on the physical, biological, or administrative environments, but is likely to result in controversy in the human environment. Alternative 8 designates a relatively large amount of diverse habitats as HAPC, which is likely to generate opposition from one sector or another. Designation of HAPC will result in indirect impacts due to two other provisions of the M-S Act. First, increased conservation scrutiny may occur when addressing adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, increased conservation scrutiny may occur when addressing Federal agency actions that may EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act.

2.5 Identify alternatives for preventing, mitigating, or minimizing adverse effects of fishing on EFH

2.5.1 Organization of alternatives

Section 3.2 (Affected Environment) describes the species managed under the Gulf of Mexico FMPs, their known prey, and the habitat used by those species for ecological functions (spawning, breeding, feeding, and growth to maturity), to the degree known. Through the determination of a Preferred Alternative for each species or FMP (Section 2.3), EFH is described and identified for all species and their life stages managed in the seven Gulf of Mexico FMPs. Fishing activities or gear use that cause adverse impacts to EFH that are more than minimal or temporary must be assessed, and alternatives must be identified to prevent, mitigate, or minimize the adverse impact.

Seven alternatives for preventing, mitigating, or minimizing adverse effects of fishing on EFH are presented. Each alternative represents a package of several individual measures that affect the use of fishing gears allowed under the Gulf of Mexico FMPs. The table at the end of this section summarizes the possible actions, the habitats, and the FMPs that will be affected.

The Council also requested that the following concepts for addressing potential adverse impacts be utilized: no action; alteration of gear to reduce impacts (gear modifications); restricting the use of gear in affected areas; and prohibiting gear in affected habitat. The last three can indirectly result in reduced fishing effort, the last concept. For some types of impacts, there may be several options for preventing, mitigating, or minimizing actions that span all of these categories. For others, due to the nature of the impact, habitat, and/or the gear used, there are essentially only two options: no action or prohibition.

Some gear modifications might be relatively easy to implement, without substantial cost or loss of efficiency. However, time/area closures, while having greater potential for mitigating impacts, might result in a greater restriction on fishing activity and therefore carry a greater burden for the fishers. Total prohibition of gears is the most restrictive management measure that could be imposed.

Implications of fishing impacts alternatives

Each individual action may be required (be enacted) on one or more specific habitats in the Gulf of Mexico, denoted by [. It will be relevant or have an impact on specific fishery management plans (FMPs), also denoted by [.
A few gears restrictions are not applicable (NA) on certain habitat types, because existing restrictions already keep that gear out of certain habitat areas (i.e. longline on submerged aquatic vegetation in waters less than 20 fathoms). Finally, the result of the potential individual action could create a type of marine protected area (MPA) on the specified habitat(s) or regions designated by the action, denoted by [.

Actions that will be grouped into Alternatives	Habitats				FMPs							Could create an
	Coral	Live/hard bottom	SAV	Sand-soft bottom	Red Drum	Reef Fish	Coastal Migratory Pelagics	Shrimp	Stone Crab	Spiny Lobster	Coral	
Prohibit bottom trawling over coral reefs	[							[			[	[
Require the use of circle hooks and weights or sinkers of no more than 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs or handlines	[	[				[	[					
Require recreational and commercial vessels fishing with vertical gear, powerheads, spears, bully nets, snares, or hand harvest to use buoys on all anchors ('anchor-ball' retrieval)	[	[	[			[	[			[	[	
Prohibit the use of anchors on coral or live hard bottom. Recreational and commercial vessels fishing with vertical gear, powerheads, spears, bully nets, snares, or by hand harvest, could use mooring buoys if installed.	[	[				[	[		[	[	[	[

Actions that will be grouped into Alternatives	Habitats				FMPs							Could create an
	Coral	Live/hard bottom	SAV	Sand-soft bottom	Red Drum	Reef Fish	Coastal Migratory Pelagics	Shrimp	Stone Crab	Spiny Lobster	Coral	
Prohibit the use of trotlines while fishing with traps or pots and require a buoy attached to each individual trap/pot set.	[	[	[						[	[		
Prohibit the use of bottom longlines greater than six (6) miles in length and limit the number of sets to no more than three (3) per day (recommendation for HMS FMP as well).		[				[						
Prohibit the use of bottom longlines greater than five (5) miles in length and limit the number of sets to no more than three (3) per day (recommendation for HMS FMP as well).												
Prohibit the use of bottom longlines, buoy gear, and all traps/pots	[	[	[			[			[	[		[
Require shrimp fishing operations to use aluminum doors, rather than wooden doors on their nets.		[	[					[				
Require total shrimp net headrope length of no more than 180' and vessels to be 85' or smaller in overall length		[	[	[				[				
Require total shrimp net headrope length of no more than 120' and vessels to be 81' or smaller in overall length.		[						[				
Limit the use of tickler chains.		[	[	[				[				

Actions that will be grouped into Alternatives	Habitats				FMPs							Could create an
	Coral	Live/hard bottom	SAV	Sand-soft bottom	Red Drum	Reef Fish	Coastal Migratory Pelagics	Shrimp	Stone Crab	Spiny Lobster	Coral	
Require a weak link in the tickler chain of bottom trawls.	[	[	[	[				[				
Enact a seasonal closure for shrimp trawling on live hard bottom.		[						[				[
Prohibit the use of all trawling gear.	[	[	[	[				[				[
Prohibit the use of all vertical gear.	[	[	[			[	[					[
Prohibit the use of all traps and pots.	[	[	[			[			[	[		[
Prohibit the use of all spears and powerheads.	[	[				[						[
Prohibit the use of all bottom longline and buoy gear.	[	[	NA			[						[
Prohibit the use of all gear types.	[	[	[			[	[	[	[	[	[	[
<u>Considered but rejected</u>												
Prohibit the use of bottom longlines greater than 2 miles in length and limit the number of sets to no more than three per day on coral.	[					[						

Actions that will be grouped into Alternatives	Habitats				FMPs							Could create an
	Coral	Live/hard bottom	SAV	Sand-soft bottom	Red Drum	Reef Fish	Coastal Migratory Pelagics	Shrimp	Stone Crab	Spiny Lobster	Coral	
Limit the number of active vertical lines (or hand lines) to three (3) per commercial vessel during any period of active fishing, and limit the days per trip to no more than five (5).	[	[				[	[					
Limit the number of individuals fishing with spears/powerheads during commercial or recreational fishing trips to 3 per vessel.	[	[				[						

2.5.2 Alternative1. (No Action, status quo). Use existing regulations to prevent, mitigate, or minimize adverse fishing impacts in State and Federal waters of the Gulf of Mexico

Under this alternative, no new actions would be introduced. Existing management measures put in place by the Council and NOAA Fisheries that contribute to preventing, mitigating, or minimizing adverse effects of fishing on EFH would remain in place. The Council and NOAA Fisheries would address future management actions on a case-by-case basis within the existing FMP management framework.

Few specific research efforts have assessed the direct impacts of gear use in the Gulf of Mexico on habitat that may be identified as EFH (Section 2.1.5). Although lack of area-specific studies on the effects of fishing on EFH is insufficient justification to postpone management measures altogether (NRC 2002), not introducing specific measures through this EIS to prevent, mitigate, or minimize the effects of fishing on EFH does not mean that there will be no protection from fishing to these habitats. Many types of identified habitats are currently protected by fishing area closures and gear restrictions. In some cases, habitat protection has resulted from Council and NOAA Fisheries management action aimed directly at habitat protection, while in other cases habitat protection occurred as an ancillary benefit of management measures designed for other purposes.

The Tortugas North and South Marine Reserves are no-take marine reserves and protect 185 square nautical miles. Much of the reserve is coral reef and areas identified as important spawning sites for black, red, gag, Nassau, and yellowfin grouper; scamp and hinds (Ault, *et al*. 1998); and gray, mutton, cubera, yellowtail, and dog snapper.

Regulations in the Coral Reef FMP since 1984 prevent the use of gear interfacing with the bottom in the Flower Garden Banks HAPC and the Florida Middle Grounds HAPC. The Flower Gardens is the most northern hard coral complex in the Gulf of Mexico, and some hard coral exists at the Florida Middle Grounds; both areas have extensive live and hard bottom areas. Use of bottom longline, bottom trawl, dredge, pot or trap is prohibited year round. Fishing over these areas (trolling, pelagic longlines) or by vertical gear, spears or powerheads, is not banned. Vertical gear, spears and powerheads are considered to potentially have minor impacts in coral reef areas (see Section 3.5.2.1).

A variety of habitats in the Tortugas Shrimp Sanctuary (hard bottom, sand/shell, soft bottoms, sea grasses) are protected from all trawl fishing, and the vast area of the Gulf inside the Longline and Buoy Gear Restricted Area are protected from use of bottom longlines, fish traps, and fishing with powerheads. Information on gear restrictions is discussed in Section 3.4.1.2.2 on the history of management, and further details on each FMP Amendment are given in Appendix A.

However, this alternative provides no specific protection to hard bottom communities, particularly the extensive area that has scattered hard bottoms, on the west Florida shelf. The relative impacts of bottom longlines and all traps, outside closed areas, is greatest on this habitat, as compared to other habitats such as sand, silt, and clay (Figures 3.5.18b, 3.5.19, 3.5.24, 3.5.25).

Even the relative impact from vertical gear, spears and powerheads, though less compared to longlines and traps, has the most potential impact on hard bottom.

Thus, any ongoing trends in damage to geological features and marine habitats from fishing gears would continue, barring other external factors. If the habitat damage leads to reductions in abundance for any species, that decline would also continue. Available information does not provide conclusive evidence that any managed species are currently habitat limited, however habitat limitation could occur, but go undetected. It is also not clear how much habitat damage has occurred from adverse impacts of fishing.

Areas most likely to be adversely affected include hard bottoms of the West Florida Shelf, Florida Bay, and banks along the outer continental shelf from Mississippi to Texas. The additional benefits of fishing management beyond status quo protection, as listed under the other alternatives, would not be gained with Alternative 1. There would be no short term impacts to fishermen or fishing communities, however, over the long term, there could be negative impacts due to habitat damage or loss that results in declines in stocks of fish. Administratively, there would be no change due to this alternative.

2.5.3 Alternative 2. Establish minor modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

6. No bottom trawling over coral reef
7. Require aluminum doors on trawls
8. Limit bottom longline sets to 6 miles in length, limited to 3 sets/day on hard bottom
9. Require circle hooks on all vertical lines and allow maximum sinker weights of 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs, or handlines
10. Require use of buoys on all anchors

Action	**Coral**	**Hard bottom**	**SAV**	**Sand/soft sediments**
No bottom trawling over coral	[			
Require aluminum doors on trawls		[	[	[
Limit bottom longlines to 6 miles, 3 sets/day on hard bottom		[		
Require circle hooks, on all vertical lines, and maximum weights of 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs or handlines	[	[		
Require use of buoys on all anchors	[	[	[	

Action creating a closure	**Gear Closure**	**Area Closure**
No bottom trawling over coral		[

Trawl impacts
Trawl fishing has the potential to have a high impact on coral reef, and modification to trawl fishing reduces this high impact. Coral reefs are highly structured, and rise off the sea floor bottom. Direct contact of trawls entangles, tears and crushes reef structures. Most of the area of known, mapped coral reef is already protected from trawl fishing. Trawling is banned in the Florida Middle Grounds, East and West Flower Garden Banks, the Tortugas North and South Reserves, Riley's Hump, and the Tortugas Shrimp Sanctuary.

Shrimp trawling has the potential to moderately impact bottom habitats other than coral, as described in Section 3.5.2.1.1, and the contact of doors with the benthos contribute to these impacts. Shrimp fishermen use either wooden or aluminum while trawling. Both types are designed with buoyancy chambers to allow them to operate off the bottom to spread the opening of the net. Wooden doors will tend to lose their buoyancy sooner and may begin to dig in too deep or not tow the net properly; when this happens it is a signal to the fisherman to replace his doors. While aluminum doors last longer and do not lose their buoyancy in the same way (thus less frequently begin to dig or drag), they cost significantly more. With respect to the bottom, this alternative considers aluminum doors to have slightly less impact than wooden doors.

Over the last five years, it has been reported (Texas Sea Grant Agents, personal communication) that many shrimp fishermen have switched to aluminum trawl doors. The actual percentage of fishermen that would have to switch from wooden to aluminum doors, if this action was a preferred action, is not known at this time. NOAA Fisheries has begun a socioeconomic assessment of shrimp fishermen in Texas, and plans to implement a similar study in the other Gulf states in 2004, which would allow a more accurate economic assessment of this alternative. A phase-out of wooden doors in favor of aluminum would alleviate the economic burden to some extent, since it appears that fishermen are already gradually changing over of their own volition. However, due to the relatively minor environmental benefit and significant cost difference to fishermen, this action is not considered practicable.

Bottom longline gear
Bottom longline gear has the potential to cause moderate adverse impacts to coral and hard bottom habitats (See Section 3.5.2.1.6) depending upon how it is deployed, and sea state conditions. The gear can cause pulling and tearing of soft structures in coral habitat; breakage of branching corals; and scraping of polyps on large coral heads, depending on the line's sweep and amount of dragging that might occur. Bottom longline sets used to catch reef fish average lengths of 7.81 miles (NOAA Fisheries Logbook data, 1990-2001). Setting a limit on the length and number of sets per day near the average should reduce potential impacts by approximately 23% if fishers currently make 3 sets per day. Otherwise, a time effort limit (days fished) could also be set. NOAA Fisheries could establish similar restrictions for bottom longline fishing for sharks. It has been reported that fishermen prefer to set and retrieve approximately 20 miles of longline per day (B. Spaeth, personal communication), and this alternative would allow 18 miles to be set, approximately 10% less.

It is not possible to quantify what the total benefit to habitat of this action might be nor its potential positive effect on targeted populations of fish. Any benefit would require that this actually limited effort over hard bottom, and it was not simply displaced to other regions or habitats. This management action would be difficult to enforce because of the need for enforcement agents to measure line length, and to monitor how much of a line is set over hard bottom.

Vertical gear

Vertical gears are allowed in some protected coral reef areas and generally in hard bottom areas in the Gulf of Mexico. Vertical gear hooks and line and weights or sinkers can become entangled on coral causing abrasion or breakage, as can the use of J hooks, weights and line can snag on delicate gorgonians, sponges, and other benthic species that reach up from the seabed. J hooks can also snag on coral and cause breakage. Due to widespread use of vertical gear with weights over coral and hard bottom habitat, the cumulative effect may lead to impacts that are more than minor. Use of circle hooks only should reduce the incidence of entanglement of vertical gear on coral habitat. Additionally, limiting the weight of sinkers to no more than 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs or handlines will provide some protection to corals and hard bottom species from sinker/weight damage. However, there are no data on weights actually used by commercial or recreational fishermen, so the amount of environmental protection offered by this measure is not completely known.

This measure would be extremely difficult to enforce and would essentially require voluntary compliance. Since there are no data on how much sinker or weights are actually used by fishermen, it is not possible to quantify the economic impact of this action.

Sliding buoys

Sliding buoys on anchor lines help the anchor to lift up more vertically than with unbuoyed lines. Anchors with line-buoys are less likely to drag along the bottom than anchors without line-buoys, thus reducing the damage and negative impact to fragile coral and hard bottoms. Dragging anchors could also cause damage to seagrass and benthic algae. The amount of damage actually caused by anchors to habitats is not known; there is no way to quantify the total number of recreational and commercial boat or vessel trips in the Gulf of Mexico that require anchoring.

One proposed system to reduce potential damage consists of an "anchor-ball," a welded ring, a 3-foot section of line, and a clip on the line. Using this system, one can pull an anchor with very little effort. The ring is clipped around the anchor line, the ball tossed overboard, and the anchor line slides through the ring, allowing the ball to float the anchor to the surface, while being pulled to the boat and the anchor line is stowed. According to size, the systems can cost between $45 to $60. This may be considered relatively small per vessel, however, there are no data to quantify the potential environmental benefits this action may have on habitats. Like the other actions above, this would be extremely difficult to enforce, and thus may not be practicable. It may have merit as a recommended voluntary action on the part of boaters and fishers and would require an outreach program to educate boaters on the potential environmental benefits.

Limiting these various actions to particular habitats that are not well mapped, also makes implementation of these management actions difficult for fishermen and enforcement agencies.

Overall, these actions are not practicable for protecting EFH.

2.5.4 Alternative 3. Establish moderate modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ

In addition to the restrictions listed in Alternative 2, apply the following action items:

5. Limit use of tickler chains to one chain with a maximum ¼ inch link diameter
6. Limit total trawl headrope length to 180 feet or less
7. Limit trawl vessels to 85 feet or less LOA, and grandfather existing vessels
8. Prohibit trotlines when using traps/pots

Action	**Coral**	**Hard bottom**	**SAV**	**Sand/soft sediments**
No bottom trawling over coral	[			
Require aluminum doors on trawls		[	[	[
Limit longlines to no longer than 6 miles and 3 sets/day (other restrictions already keep longline off SAV)		[		
Require circle hooks, on all vertical lines, and maximum weights of 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs or handlines	[	[		
Require use buoys on all anchors	[	[	[	
Limit use of tickler chains to one chain, ¼ inch		[	[	[
Limit total trawl headrope length to ≤ 180', vessels to ≤ 85' or smaller LOA		[	[	[
Prohibit trot lines when using traps/pots	[	[	[	

Action creating a closure	**Gear Closure**	**Area Closure**
No bottom trawling over coral		[

Shrimp trawlers use tickler chains to cause shrimp to jump off the bottom and pass over the footrope into the net (Harrington *et al*. 1988). Fishers usually use 1/4 or 5/16 inch diameter chains. Harrington *et al*. (1988) tested both chain diameters on 50-foot flat nets. The 1/4-inch chain increased net spread by 2-feet over the 5/16-inch chain and by 1-foot over the net with no tickler chain. The 1/4-inch chain did not cause the footrope to dig into the bottom as much as with the 5/16-inch chain. Therefore, the 1/4-inch chain causes less direct contact with the bottom, but over a slightly larger area.

Currently, it is roughly estimated that about 50% of the shrimp fleet uses either one 60-foot net or two 30-foot nets (total 60 feet of headrope), and the other 50% of the fleet uses four 45-foot nets (total 180 feet of headrope) (Sheridan, from 1997 NMFS vessel statistics files). Dr. Sheridan (NOAA Fisheries Galveston Laboratory) estimated that the area swept per day by vessels with a 60-foot total headrope equals 167 hectares as compared to 516 hectares swept by vessels with a

180-foot total headrope (based on average tow speed).[15] He assumes that the net spread is 70% of the headrope length. Vessels using these types of gear configurations are generally 85-feet in length or smaller. However, some vessels are being built as large as 90- to 100- feet in length, with twin engines, and the capacity to pull four 75-foot nets (total 300 feet of headrope). Thus, this measure prohibits vessels longer than 85 feet (with the exception of existing grandfathered vessels), which have the potential to sweep 40% more area than vessels with a total of 180 feet of headrope length. In Texas, approximately 5.6% of the US Coast Guard documented shrimp fishing vessels exceeded 85-feet in length in 2001 (M. Travis, personal communication).

Pulling along trotlines can cause dragging of line and traps along the bottom, actions that can be detrimental to habitat with high relief, such as coral. The area swept by trotlines during trap recovery can be much greater than the cumulative area of the individual traps themselves.

2.5.5 Alternative 4. Establish major modifications to fishing gears and gear closures on sensitive habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ

In addition to the restrictions listed in Alternative 3, apply the following action items:

6. Limit total trawl headrope length to 120 feet or less
7. Limit trawl vessels to 81 feet or less LOA on hard bottom or SAV
8. Prohibit use of tickler chains on hard bottom, SAV, sand/shell, and soft sediments
9. Prohibit use of all traps/pots and bottom longlines and buoy gear on coral reef
10. Prohibit all use of anchors on coral, and require use of mooring buoys if vessels need to "anchor" or maintain a stationary position

Action	**Coral**	**Hard bottom**	**SAV**	**Sand/soft sediments**
No bottom trawling over coral	[			
Require aluminum doors on trawls		[	[	[
Limit longlines to no longer than 6 miles and 3 sets/day (other restrictions already keep longline off SAV)		[		
Require circle hooks, on all vertical lines, and maximum weights of 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs or handlines	[	[		
Require use buoys on all anchors		[	[	
Prohibit trot lines when using traps/pots		[	[	
Limit total trawl headrope length to $\leq$ 180', vessels to $\leq$ 85' or smaller LOA on sand/soft bottoms				[
Limit total trawl headrope length to $\leq$ 120', vessels to $\leq$ 81' or smaller LOA on hard bottom or SAV		[	[	

[15] Vessel speed: 5.6 km/h x 24 h = 134.4 km/d = 134,400 m/d
Net spread or area swept: 50% of tows at 60' x 0.7 = 42' = 12.4 m, 50% of tows at 180' x 0.7 = 126' = 38.4 m
Area swept per day (60') = 134,400 m/d x 12.4 m = 1,666,560 m2/d = 167 ha/d
Area swept per day (180') = 134,400 m/d x 38.4 m = 5,160,960 m2/d = 516 ha/d)

Prohibit use of tickler chains on hard bottom, SAV and sand/soft sediments		[	[	[
Prohibit use of all traps/pots and bottom longlines & buoy gear on coral	[			
Prohibit all use of anchors on coral, and require use of mooring buoys if vessels need to "anchor" or maintain a stationary position.	[			

Action creating a closure	**Gear Closure**	**Area Closure**
No bottom trawling over coral; prohibit use of all traps/pots and bottom longlines & buoy gear on coral; and prohibit all use of anchors on coral, and require use of mooring buoys if vessels need to "anchor" or maintain a stationary position.		[
Prohibit use of tickler chains on hard bottom, SAV and sand/soft sediments	[	

Dr. Sheridan (NOAA Fisheries Galveston Laboratory) estimated that the area swept per day by trawl vessels with a 60-foot total headrope equals 167 hectares as compared to 516 hectares swept by vessels with a 180-foot total headrope (based on average tow speed).[16] He assumes that the net spread is 70% of the headrope length. The average number of days fished per NOAA Fisheries statistical grid per year (for 2000 and 2001) is presented in figures from Section 3.3. If larger vessels that usually use quad rigs were limited to individual trawl headropes no longer than 30-feet, similar to those used by smaller vessels, this would equal 120-feet of total headrope length. This alternative would result in area swept per day by any vessel to not exceed 344 hectares over hard bottom (or 33.3% of 516 hectares).

Shrimp trawlers use tickler chains to cause shrimp to jump off the bottom and pass over the footrope into the net (Harrington *et al*. 1988). The disruption to the bottom sediments from interactions with tickler chains would diminish. However, prohibition on tickler chains would substantially reduce the amount of shrimp caught per tow, particularly for brown and pink shrimp species. White shrimp generally do not burrow like brown and pink shrimp, thus catch for this species should not be greatly reduced. Any significant reduction in technological efficiency would likely result in marginally profitable operations leaving the industry and other vessels moving into state waters, where possible, to avoid the increased restrictions.

Since traps and pots can have moderate adverse impacts on coral reef habitat, this alternative provides complete protection from the adverse impacts. Likewise, bottom longlines are considered to have moderate adverse impacts, but the full scope of potential impacts from the

[16] Vessel speed: 5.6 km/h x 24 h = 134.4 km/d = 134,400 m/d
Net spread or area swept: 50% of tows at 60' x 0.7 = 42' = 12.4 m, 50% of tows at 180' x 0.7 = 126' = 38.4 m
Area swept per day (60') = 134,400 m/d x 12.4 m = 1,666,560 m2/d = 167 ha/d
Area swept per day (180') = 134,400 m/d x 38.4 m = 5,160,960 m2/d = 516 ha/d)

potential sweep and drag of the line across coral habitat is unknown. This alternative takes the most precautionary position with respect to these two types of fishing operations.

Anchoring likely causes the most impact from commercial or recreational fishing operations that use hand lines, powerheads and spears, and all other hand harvesting types of fishing. Prohibiting anchoring and requiring the use of mooring buoys eliminate these adverse impacts. Use of mooring buoys is a proven way to both allow fishing activity and protect delicate coral habitats from the damage of anchoring and the swinging and chafing of anchor chain and line. However, using mooring buoys requires a new level of management. It would require a review of fishing patterns to determine the wisest and most useful locations, underwater surveys to identify appropriate specific locations and substrates, the installation of the buoys, and a monitoring and maintenance program. In the U.S., the mooring buoy system does work successfully along the Florida reef track, but it is partnered with monitoring, maintenance and an enforcement program. Use of a required mooring buoy system is essentially establishing a vessel carrying capacity for a reef or reef area, depending on the number of mooring buoys deployed, their size, and number of vessels that can actively use a single mooring buoy. It would equally affect commercial fishing operations, charter or headboats, and private fishing vessels.

Each of the actions to prohibit particular gear use on coral habitat, in effect establishes coral reefs as one type of area closure or marine protected area. The only fishing gears that are not listed as prohibited on corals are vertical gears, spears and powerheads. Several existing MPAs within the Gulf of Mexico do allow some use by certain gears, and this alternative would be established in a similar fashion.

2.5.6 Alternative 5. Prohibit gears and fishing activities that have adverse impacts on EFH from the EEZ

Apply the following action items:

1. Prohibit use of all bottom trawling gear
2. Prohibit use of all traps and pots
3. Prohibit use of all bottom longline & buoy gear
4. Prohibit use of all spears and powerheads
5. Prohibit use of all vertical gear
6. Prohibit use of all anchors

Action	Coral	Hard bottom	SAV	Sand/soft sediments
Prohibit use of all bottom trawling gear	[	[	[	[
Prohibit use of all traps and pots	[	[	[	
Prohibit use of all bottom longline & buoy gear	[	[	NA[17]	
Prohibit use of all spears and powerheads	[	[	[	
Prohibit use of all vertical gear	[	[	[	
Prohibit use of all anchors	[	[	[	

Action creating a closure	Gear Closure	Area Closure
Prohibit use of all bottom trawlin g gear		[
Prohibit use of all traps and pots		[
Prohibit use of all bottom longline & buoy gear		[
Prohibit use of all spears and powerheads		[
Prohibit use of all vertical gear		[
Prohibit use of all anchors		[

Discussion and rationale

Each of these gears and fishing operations has potential fishing impacts that are more than minimal or temporary on coral, hard bottom, and SAV, and sand or soft sediments for trawl gear. Thus, prohibition of the use of any individual fishing operation or gear type is the most precautionary way to directly protect all fish habitat not already under complete protection. If all the actions were implemented, very large areas of the Gulf of Mexico would be completely closed to fishing activities.

The costs associated with this 'bundle' of actions would be very large. In the short-run, it would almost certainly result in a significant reduction in net economic benefits to the commercial fishing sector (likely driving them close to zero) and it appears likely that even the long-run benefits to the sector would be less than under the No Action alternative. Some commercial and recreational fishermen would attempt to avert the restrictions in Alternative 5 by moving to state waters (where possible). This would certainly create crowding externalities. Larger vessels, unable to avert the restrictions by altering fishing practices, would exit the fishery. In addition, vital support industries that supply vessels with gear, fuel, repairs and groceries would be impacted.

There may, however, be two primary beneficiaries associated with implementation of Alternative 5. First, non-consumptive users may benefit if implementation of Alternative 5 does result in protection/enhancement of essential fish habitat. Similarly, individuals "willing to pay" for the existence of a pristine habitat (independent of using the habitat) would benefit.

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[17] Bottom longline and buoy gear cannot be used in areas of SAV habitat because this is all contained within the Longline and Buoy Gear Restricted Area.

Overall, the benefits would have to be very large to justify Alternative 5 from an economic efficiency point of view. As noted in the introduction, a certain amount of habitat degradation is usually permissible under the concept of economic efficiency, the exact amount dependent upon the divergence of marginal private and marginal social costs. Only if external costs are very large would one conclude that implementation of Alternative 5 would result in an increase in net economic benefits.

2.5.7 Alternative 7. Establish some minor modifications to fishing gears and one major gear closure on sensitive live hard bottom habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ.

Apply the following action items on live hard bottom:

5. Limit bottom longline sets to 5 miles in length, and to 3 sets/day
6. Prohibit trotlines when using traps/pots
7. Prohibit all anchoring
8. Enact a seasonal closure for shrimp trawl fishing

Action	**Coral**	**Hard bottom**	**SAV**	**Sand/soft sediments**
Limit bottom longline sets to 5 miles in length, and to 3 sets/day		[		
Prohibit trotlines when using traps/pots		[		
Prohibit all anchoring		[		
Enact a seasonal closure for shrimp trawl fishing		[		

Action creating a closure	**Gear Closure**	**Area Closure**	**Seasonal Closure**
Prohibit all anchoring	[	[	
Enact a seasonal closure for shrimp trawl fishing		[	[

<u>Discussion and rationale</u>

Bottom longline gear has the potential to cause moderate adverse impacts to live hard bottom habitats (See Section 3.5.2.1.6) depending upon how it is deployed and sea state conditions. The gear can cause pulling, tearing, or breakage of any species that attaches to hard bottom (gorgonians, sponges, individual corals colonies or head), depending on the line's sweep and amount of dragging that might occur. Bottom longline sets used to catch reef fish average lengths of 7.81 miles (NOAA Fisheries Logbook data, 1990-2001). Setting a limit on the set length to 5 miles should reduce potential impacts by approximately 36% if fishers currently make 3 sets per day (13% greater reduction than if lines were limited to 6 miles in length, as in other alternatives). If there were not a limit to the number of sets per day, a time effort limit (days fished) could also be set. NOAA Fisheries could establish similar restrictions for bottom longline fishing for sharks (under the HMS FMP). It has been reported that fishermen prefer to set and retrieve approximately 20 miles of longline per day (B. Spaeth, pers. comm.), and this alternative would allow 15 miles total to be set, approximately 25% less.

It is not possible to quantify what the total benefit to live hard bottom this action might be nor its potential positive effect on targeted populations of fish. Any benefit would require that this limits total effort over hard bottom, and does not simply displace effort to other regions or habitats. However, longline fishing is already restricted to depths greater than 20 or 50 fathoms in the entire Gulf, which already protects the substantial hard bottom areas off the west coast of Florida, thus overall benefit to habitat would likely not be substantial. Additionally, this management action would be difficult (though not impossible) to enforce due to the need for enforcement agents to have a way to quickly measure line length, and to monitor how much of a line is set over hard bottom. Alternative methods for enforcement include using VMS equipment that is linked to vessel engines and machinery. Vessels move at different speeds when they are setting or hauling line, as compared to steaming to a fishing site. The social and economic impacts of this action are difficult to determine on fishermen at this time.

Anchoring likely causes the most impact from those commercial or recreational fisheries for which anchoring is critical to the fishing operation. These would include fisheries that use hand lines, powerheads and spears, and all other hand harvesting types of fishing. Prohibiting anchoring on live hard bottom (and possibly requiring the use of mooring buoys) eliminates the adverse impacts. Use of mooring buoys is a proven way to both allow fishing activity and protect live hard bottom habitats from the damage of anchoring and the swinging and chafing of anchor chain and line. However, using mooring buoys requires a new level of management, as discussed under Alternative 5. In the U.S., the mooring buoy system does work successfully along the Florida reef track, but it is partnered with monitoring, maintenance and an enforcement program. This action essentially establishes a vessel carrying capacity for live hard bottom areas, depending on the number of mooring buoys deployed, their size, and number of vessels that can actively use a single mooring buoy. It would equally affect commercial fishing operations, charter or headboats, and private fishing vessels.

Pulling along trotlines while using traps can cause dragging of line and the traps along the bottom, actions that can be detrimental to habitat with high relief, such as live hard bottom. The area swept by trotlines during trap recovery can be much greater than the cumulative area of the individual traps themselves. Thus prohibiting this activity greatly protects the habitat while still allowing fishing activity to occur.

Closing particular areas or times of year to shrimp trawl fishing is a management measure currently in use in the Gulf of Mexico. The Tortugas Shrimp Sanctuary in the Florida Keys (Section 3.5.1.1) is a type of marine protected area, permanently closed to the use of all trawls (Fig. 3.3.1) for more than 30 years. The Cooperative Texas Shrimp Closure is a seasonal closure off the entire coast of Texas out 200 miles and covering 5,475 nm^2 of predominantly clay, sand, and silt, with some live hard bottom (Figure 3.3.1). The Gulf Council and State of Florida also cooperatively manage seasonal closures for shrimp and stone crab fishing off central and southwest Florida predominantly to resolve gear conflicts and to protect juvenile stone crab.

Closing all live hard bottom habitat seasonally would predominantly impact fisherman from Florida, as the primary areas that are currently mapped as mixed live hard bottom and sand lie predominantly off the west coast of Florida from approximately Crystal River to Naples out to approximately 20 fathoms depth (Fig. 3.1.3); around the Keys; and in a band to the north of the Keys. The final large area is in deeper water, included in the area now mapped as Pulley's Ridge (Fig. 2.3.21). It has not yet been determined what season or time of year would be best for a closure, nor for what duration. To be beneficial, it would have to cover some portion of the current primary shrimp fishing seasons.

However, this region of the Gulf receives predominantly the lowest shrimp fishing pressure, based on shrimp fishing effort data for 2000 and 2001 (Fig. 3.3.8). The statistical areas over the large mixed sand-live hard bottom area averaged less than 81 days fished per year, the lowest category on the scale. Whether this fishing pressure was spread out within the statistical area, or was concentrated on certain parts of the region is impossible to determine, thus the benefits are equally difficult to quantify. This action would be easier to monitor, and the benefits easier to quantify, if vessels in the fishery were also required to carry VMS. But the lack of this type of specificity, along with the fact that shrimp fishing pressure is lowest in these areas, make this action difficult to justify at this time.

2.6 EFH concepts, HAPC alternatives and fishing impacts actions considered but rejected

This section lists the EFH concepts, HAPC alternatives and fishing impacts actions that were considered but eliminated from detailed study.

2.6.1 EFH concepts

2.6.1.1 Concept 3: List of specific habitat types

EFH alternatives under this considered but rejected concept would describe and identify EFH as all waters of the Gulf of Mexico within the known distribution range of managed species and their life stages that include submerged aquatic vegetation (SAV), mangroves, marshes, oyster beds, reefs, rocky coral reefs, octocoral reefs, hard/live bottoms, ledges, outcrops, *Sargassum*, and clay substrates.

This concept specifies habitats that FMP species are generally known to use, but does not relate habitat use of species-life stages to the habitats. The selected habitats are similar to the habitats listed in alternatives developed under Concept 2, and the overall distribution of EFH identified by alternatives developed under this concept would not differ substantially from alternatives under Concept 2. However, if a species-life stage from any of the four FMPs had used a habitat not listed under this concept, then that habitat would not be described and identified as EFH. Alternatives developed under this concept would not have fulfilled the requirements of the EFH Final Rule for any of the seven FMPs.

This concept limits the definition of EFH to explicit habitats, rather than defining it through functional requirements of managed species (spawning, breeding, feeding or growth to maturity), due to the lack of existing information. Many Gulf of Mexico species have an affinity for particular habitats at different life stages and this list includes these known habitats. This concept would have simplified EFH designation and made the designated habitats more apparent to stakeholders. However, it relied on current information about the distribution of habitat types. Depending on knowledge about the locations of specific submerged habitats and the extent of existing habitat mapping, this concept could have result in the exclusion of some areas that are presently important for some fish species at various life stages.

2.6.1.2 Concept 7: Salinity range

Alternatives under this concept would have described and identified essential fish habitat based on a range of salinity corresponding to the preferred range of species and life stages listed in the FMP

The Generic Amendment contains fish distribution information based on salinity-density information, prepared by NOS. However, neither the NOS distribution maps nor salinity isohalines were available in a GIS format at the time of preparation of the EIS, so no maps of preferred salinity ranges could be prepared for species and life stages in the FMUs of the Gulf Council's FMPs.

The National Ocean Service has related fishery-independent catch rates of several managed fish species to salinity in specific areas to map relative abundance of fish based on salinity distribution (see Appendix C). Salinity range may be used, therefore, as a crude indicator of habitat suitability for managed species and their life stages, in order to infer distribution data when no other source of information exists. As stated in the EFH Final Rule (50 CFR Part 600), in the event that distribution data are available only for portions of the geographic area occupied by a particular life stage of a species, habitat use can be inferred on the basis of information about its habitat requirements and behavior. Habitat requirements can include salinity range.

The salinity range used would need to be varied according to the species and life stage for which this concept would have been used. Adult stages of the managed fish species of the Gulf of Mexico are found predominantly offshore. Although adults of some species may be found in estuarine waters, nearshore areas are a minor component of the adult distribution. By contrast, many of the managed species have post-larvae or juvenile stages that occur in estuarine and near-shore areas. For example, 15 of the 42 species in the reef fish FMU are known to occur in seagrass, mangrove and/or marsh areas inshore, with salinity levels as low as 16 ppt.

Salinity distributions change both seasonally and annually due to changes in rainfall, river flow and freshwater run-off. While salinity may be an important factor for determining fish distribution, it becomes difficult to use a salinity boundary for delineating a geographic area as EFH for administrative purposes. If average salinity distributions were used, areas occupied and required by juvenile fish may be excluded in some seasons and years. To be the most risk averse, one would need to determine the location of the extreme boundaries of the selected salinity range.

2.6.1.3 Concept 8: Habitat suitability modeling (HSM)

Alternatives developed under this concept would have described and identified essential fish habitat as all marine waters and substrates identified as suitable fish habitat, as indicated on maps produced by high quality, spatially explicit, qualitative or quantitative information.

National Ocean Service (NOS), scientists at the Florida Marine Research Institute, and others have been collaborating to develop modeling procedures to develop indices that spatially delineate the suitability of fish habitats for fish and invertebrates (Rubec *et al*. 1999). This modeling, known as Habitat Suitability Modeling or HSM, is being conducted to help determine optimal fish habitats to support decision making for management of EFH. It integrates distribution of habitats and environmental parameters with the species affinity for each (species abundance), using a geographic information system (GIS) to identify, which are most important in explaining species abundance (Rubec and McMichael 1996). This methodology is also being employed in the US Caribbean and west coast regions for use in future identification of EFH. Several limited efforts have been undertaken in the Gulf region to predict the distribution of certain species (Sheridan 1996; Rubec *et al.* 1998; Gallaway *et al*. 1999), but no such analyses are currently available for consideration for any species within the seven FMPs. Research underway may be extended in the future to include these species. Future updates of EFH by the Council may incorporate such analyses.

2.6.2 HAPC alternatives

2.6.2.1 Alternative 5: Identify and establish habitat areas of particular concern as those habitat areas used by managed species for early life stage development, that are most in need of protection (to be determined)

This alternative is similar to Alternative 3, but is designed to establish specific, known, important nursery grounds of certain species as HAPC. Under this alternative, the process of growth of larval or juvenile individuals to maturity and the specific sites where this occurs are considered most in need of protection, based on a risk analysis (to be undertaken), to maintain the overall productivity of these identified species. Therefore, these sites would receive HAPC designation.

At this time, the Gulf Council has provided specific protection only for nursery areas of juvenile shrimp off Florida and Texas, cooperatively with those states. The permanent closure of the Tortugas Shrimp Sanctuary (about 3,600 square nautical miles) also results in similar nursery benefits for spiny lobster. According to Herrnkind and Butler (1986) the sponges and coralline algae in the sanctuary that are protected from trawling are an important nursery ground for postlaval and juvenile spiny lobster.

However, other Federal laws and regulations, such as Section 404 of the Clean Water Act, currently protect many of these areas, particularly in the nearshore or estuarine environment. Any activity that may negatively impact a wetland or waters of the U.S. are required to seek

Federal permits and must try to avoid or minimize the impact. When this cannot be accomplished, the permit seeker may be required to mitigate for any activity that could negatively alter the habitat. By adding the HAPC designation to at least some of these areas, because of their significance as nursery areas, additional protection may be afforded. HAPC designation would provide good justification to have the activity avoided, rather than simply mitigated for. Research and monitoring has shown (NRC 2001) that many mitigation efforts fall far short of their goals, do not provide suitable replacement habitat or appropriate biological function for wildlife, and/or never achieve the "no net loss" standard. Nursery areas would meet HAPC criteria "a, b, and c" in a similar manner as in HAPC Alternative 3.

However, because this HAPC alternative focused on a single aspect of ecological importance, growth to maturity, the Council rejected this alternative in favor of a new alternative (Alternative 8), which utilized all four considerations for HAPC identification listed in the Final Rule (i.e. ecological importance, rarity, stress, and vulnerability). This new alternative includes the consideration of ecological importance, but is not limited to it.

2.6.2.2 Alternative 6: Identify and establish habitat areas of particular concern as those habitat areas used by managed species as migratory routes that are most in need of protection (to be determined)

This alternative is similar to Alternative 3 and 4, but is designed to establish specific, known, important migratory routes of certain species as HAPC. This alternative considers the term "habitat" in the broader sense, as the location of specific "waters" and not just in reference to a specific bottom or vegetative type. Under this alternative migration routes of juvenile or adult individuals that are considered most in need of protection, based on a risk analysis (to be undertaken), to maintain the overall productivity of these identified species. Therefore, these sites would receive HAPC designation, and meet criteria (a).

All identified migratory routes that are in the nearshore areas, such as passes into estuaries, would also meet criterion (b) – sensitive to human-induced degradation." These regions are potentially very sensitive to dredging, shipping, and pipelines, as well as secondary impacts such as coastal development, non-point source pollution, and, potentially, fishing impacts. Additionally, for many estuaries, there are a limited number of passes, the number and location of which may be altered due to storms or coastal sand transport. Thus in some cases, a specific pass may meet criterion (d) - "rarity of habitat type." By establishing those known sites critical to migratory needs of these managed species as HAPC, all activities that pose threats to these areas should receive the highest level of scrutiny possible by both the NOAA Fisheries and the Gulf Council.

However, because this HAPC alternative focused on only limited aspects of ecological importance, the Council rejected this alternative in favor of a new alternative (Alternative 8), which utilized all four considerations for HAPC identification listed in the Final Rule (i.e. ecological importance, rarity, stress, and vulnerability). This new alternative includes the consideration of ecological importance, but is not limited to it.

2.6.2.3 Alternative 7: HAPC consist of habitats that are "limiting" to the species in some way or could be considered a "bottleneck" for production

Many fish species require very specific conditions for certain critical life history functions. Obligatory areas often exist for spawning or rearing, without which these vital processes would be severely impacted. These obligatory areas may act increasingly as a limiting factor to fish production – as the areas diminish in size or are otherwise adversely affected, the production may also start to diminish. For example, a fish species may spawn only on a special type of habitat in a limited geographic area and/or under specific physical conditions, such as temperature, tide, etc. A nursery area may consist of a particular type of vegetation or bottom type, or fish feeding may occur on other species that have specific habitat requirements. By definition of "obligatory areas," HAPCs identified under this alternative would automatically meet the first of the HAPC considerations listed in the Final rule, in that the habitat supports one or more important ecological functions. They would also be expected to be rare.

During the analysis conducted for this EIS, consideration was given to using the metrics of habitat use and habitat rarity to develop an index that could show where bottlenecks might be expected to occur (locations of habitats that are used by many species and are also rare are likely to be good candidates). It was agreed, however, that this index would likely be too imprecise and potentially misleading to use at this stage as an objective means of identifying HAPCs. It was also agreed that information at the species and life stage level would need to be considered, rather than using information across many species, such as is used in the habitat use index.

Because this alternative provided only an imprecise evaluation of a limited aspect of ecological importance, the Council rejected this alternative in favor of a new alternative (Alternative 8), which utilized all four considerations for HAPC identification listed in the Final Rule (i.e. ecological importance, rarity, stress, and vulnerability). This new alternative includes the consideration of ecological importance, but is not limited to it.

2.6.3 Actions to prevent, mitigate, or minimize the effects of fishing on EFH

Three actions to prevent, mitigate, or minimize the effects of fishing on EFH were considered but rejected at the March 2003 Council meeting. They were the following:

- Prohibit the use of bottom longlines greater than 2 miles in length, and limit the number of sets to no more than 3 per day on coral.
- Limit the number of active vertical lines (or handlines) to no more than 3 per commercial vessel during any period of active fishing, and limit the number of days per fishing trip to no more than 5.
- Limit the number of individuals fishing with spears or powerheads during commercial or recreational trips to 3 per vessel.

The Council considered these potential actions to have no significant benefit to fish habitats and also found them to be unenforceable, and are therefore not practicable.

3 AFFECTED ENVIRONMENT

3.1 Physical Environment

3.1.1 Geological features

The Gulf of Mexico basin was formed during the Jurassic Period as part of the initial breakup of Pangea as Africa/South America separated from North America. During the middle Jurassic, thick salt was deposited throughout the broad central basin area. The Gulf basin became locked in its current position with respect to North America by early Cretaceous time. Broad carbonate platforms with prominent rimmed margins became established along the edges of the basin. The margins were reefal, made up of algal, coral and rudistic banks. These carbonate shelf margins were exceptionally linear, following a line 129 to 161 km inward of the present Texas-Louisiana coastline, then turning southeast, ultimately determining the position of the Florida Escarpment. A later rise in sea level drowned the outer margins of the carbonate platforms, causing the margins to retreat to more landward positions. This sea level rise was followed by the later partial filling of the basin by large clastic sediments that prograded first from the west and northwest in late Cretaceous-early Cenozoic time and then from the north during the late Cenozoic.

Since the late Cenozoic, the Mississippi River has had a profound effect on the north-central Gulf of Mexico. The Mississippi River supplies around 450 million metric tons of sediment annually to the Gulf basin, an order of magnitude greater than all other coastal rivers in the Gulf of Mexico combined. The Mississippi River is responsible for building the vast amounts of wetlands in coastal Louisiana and since the Cenozoic the continental shelf edge has prograded in the Gulf basin as much as 402 km (Woodbury *et al*. 1973). This accumulation of sediment has reached a thickness of 3,600 m in some areas (Woodbury *et al*. 1973). This large deposition of sediment on a base of several thousand feet of mobile salt and prodelta clay has caused the movement of the underlying material to form large salt domes and diapirs near the continental shelf edge in the north-central Gulf of Mexico.

3.1.1.1 Bathymetry

The Gulf of Mexico is bounded by Cuba, Mexico, and the U.S., and has a total area of 564,000 square km (about 218,000 square miles) (Ogden no date). Over 24% of this is deep basin, over 3,000 meters deep (almost 2 miles), with a maximum depth of 3,850 meters (over 2 miles) in the Sigsbee Deep. Continental shelves occupy approximately 35% of the total Gulf area and the West Florida Shelf, at 150,000 square km (about 58,000 square miles), is the second largest continental shelf in the U.S. after Alaska.

The Gulf of Mexico continental shelf varies in width from about 280 km off southern Florida to about 200 km off east Texas and Louisiana (Figure 3.1.1). The shelf narrows to 110 km off southwest Texas. The shelf is widest in southern Florida (300 km) and narrowest off the modern Mississippi River Delta (10 km) (Rezak *et al*. 1985). The shelf is largely composed of muddy or sandy terrigeneous (formed by the erosive action of the rivers and of the ocean tides and currents) sediments from the Rio Grande River Delta to DeSoto Canyon off Pensacola, Florida. East of DeSoto Canyon, a thick accumulation of southeasterly trending carbonate rocks and evaporite sediments mainly dominate the shelf. This area has not been influenced by the massive terrigenous regime (i.e., formed by the erosive action of the rivers and the ocean tides and currents) that has occurred in other parts of the Gulf.

The continental shelf (0 - 200 m) occupies about 35.2 percent of the surface area of the Gulf, and provides habitats that vary widely from the deeper waters. The shelf and shelf edge of the Gulf of Mexico are characterized by a variety of topographic features. The value of these topographic features as habitat is important in several respects. Some of these features support hard bottom communities of high biomass and high diversity and an abundance of plant and animal species. These features are unique in that they are small, isolated, highly diverse areas within areas of much lower diversity. They support large numbers of commercially and recreationally important fish species by providing either refuge or food.

3.1.1.2 Sediments

The Gulf of Mexico can be divided into two major sediment provinces, carbonate to the east of DeSoto Canyon and southward along the Florida coast, and terrigenous to the west of DeSoto Canyon past Louisiana to the Mexican border. The soft bottom sediments of the northwestern Gulf shelf represent a complex array of particle size distribution patterns with much local variation. Darnell *et al*. (1983) tried to establish the more general sediment patterns as one basis for interpreting the shrimp and fish distributions. They mapped surface sediments in terms of the predominant classes of particle size. Sand and mixed sand were considered coarse sediments. Silt and clay were classified as fine sediments.

Coarse sediments make up the very shallow nearshore bottoms from the Rio Grande River to central Louisiana and comprise the dominant bottom type from shore to deeper water throughout the central third of the shelf. Thus, the fine sediments are limited largely to the eastern third of the shelf (which is under the influence of the Mississippi and Atchafalaya Rivers) and the southwestern third (influenced by the present or ancestral Rio Grande River). Fine sediments are also strongly represented on the outer shelf beyond the 80-m isobath. Surface sediments may affect shrimp and fish distributions directly in terms of feeding and burrowing activities or indirectly through food availability, water column turbidity, and related factors.

The continental shelf of the eastern Gulf of Mexico presents a diverse array of surface substrates (Darnell and Kleypas 1987). The benthic environments vary greatly on a local scale. West of Mobile Bay, fine-grained organic-rich silts and clays of terrestrial origin are brought to the shelf by distributaries of the Mississippi, Pearl and other rivers. These fine sediments spread eastward from the Louisiana marshes to Mobile Bay, but off the Mississippi barrier islands they are interrupted by a band of coarser quartz sand that extends to a depth of about 40 m. Another tongue of fine sediments runs southwestward from the Everglades, extending the full length of the Florida Keys. Here the surface material is fine carbonate ooze that in the nearshore sector is mixed with some organic material. A third area of fine sediments lies along the eastern flank of DeSoto Canyon. This outer shelf carbonate deposit is a shallow extension of the fine-grained slope sediments.

Coarser surface deposits include quartz sand, carbonate sand, and mixtures of the two, and the carbonate material itself is rich in the fragmented remains of mollusks, sponges, corals, algae, and foraminifera in various proportions, depending upon the locality. Quartz sand predominates in the nearshore environment to a depth of 10 m to 20 m from the Everglades northward along the coast of Florida. However, from below Apalachicola Bay to Mobile Bay it covers the entire shelf out to at least a depth of 120 m, except the immediate eastern flank of DeSoto Canyon. The outer half to two-thirds of the Florida shelf is covered with a veneer of carbonate sand of detrital origin. Between the offshore carbonate and nearshore quartz there lies a band of mixed quartz/carbonate sand.

A Map depicting Gulf sediments developed from Minerals Management Service Data is depicted in Figure 3.1.2. Because of the many factors involved in this EIS analysis, and because information of the particular sediment and bottom type that fish associate with is more general, this effort consolidated the sediment data into four major classifications: clay, hard bottom, sand and silt (Figure 3.1.3).

3.1.1.3 The West Florida shelf

The west Florida shelf is composed mainly of carbonate sediments. These sediments are in the form of quartz-shell sand (> 50 percent quartz), shell-quartz sand (< 50 percent quartz), shell sand, and algal sand. The bottom consists of a flat limestone table with localized relief due to relict reef or erosional structures. The benthic habitat types include low relief hard bottom, thick sand bottom, coralline algal nodules, coralline algal pavement, and shell rubble. The west Florida slope forms the edge of a sequence of carbonates intercalated with evaporites more than 5 km thick (Doyle and Holmes 1985).

The west Florida shelf provides a large area of scattered hard substrates, some emergent, but most covered by a thin veneer of sand, that allow the establishment of a tropical reef biota in a marginally suitable environment. The only high relief features are a series of shelf edge prominences that are themselves the remnants of extensive calcareous algal reef development prior to sea level rise and are now too deep to support active coral communities. In water depths of 70 to 90 m along the southwest Florida shelf, a series of carbonate structures forms a series of steps along the shelf (Holmes 1981). This area corresponds to the partially buried, 5 km wide reef complex known as Pulley Ridge, which does support some living coral biota (including scleractinian corals) and associated organisms in its shallowest portions. The partially buried ridge runs from an area west of the Dry Tortugas, northward for approximately 100+ km (see Section 3.2.2.1). The shelf edge is marked by a double reef trend in water depths of 130 and 300 m (Doyle and Holmes 1985). This reef forms the feature named Howell Hook by Jordan and Stewart (1959). Howell Hook is an arcuate ridge running northward for approximately 105 km.

The lower reef crests at about 210 m in the south and 235 m in the north and forms a 40-m high scarp (Holmes 1981).

Moe (1963) described hundreds of offshore fishing areas along the west Florida coast. Moving northward along the west Florida shelf are areas with substantial relief. In an area south of the Florida Middle Grounds, in water depths of 46 to 63 m, is a ridge formed from limestone rock. Moe (1963) termed this area the Elbow, and it is about 5.4 km at its widest and has a vertical relief of 6.5 to 14 m. South of Panama City are two notable areas with high relief. The Whoopie Grounds are located in 66 to 112 m of water and have rock ledges with 6 to 8 m of relief and are covered with coral and other invertebrate growth (Moe 1963). The Mud Banks are formed by a ledge that has a steep drop of 5 to 7 m. The ledge extends for approximately 11 to 13 km in 57 to 63 m of water (Moe 1963). The "3 to 5s" are located southwest of Panama City in water depths of 31 to 42 m of water. The ledges are parallel to the 36.5-m isobath and have relief of 5.5 to 9 m (Moe 1963).

No-take marine reserves established by an August 1999 Reef Fish Regulatory Amendment (May 2000) and sited on gag grouper spawning aggregation areas where all fishing is prohibited (219 snm). The area is described in Moe's (1963) fishing survey as having rock ledges with relief up to 5 fathoms (9 m). There are outcrops of limestone and reef fish habitat (Chris Gledhill, Pascagoula NMFS lab, personal communication), and transects through this area by Ludwick and Walton (1957) showed pinnacle trends. These marine reserves were established for 4 years while they are evaluated.

The growth of coralline algae at mid-shelf depths (60 to 80 m), which results in the production of algal nodules and a crustose algal pavement, provides an extensive emergent substrate for the development of deepwater hermatypic corals. The biological description of the west Florida shelf is presented in detail in Section 3.2.2.2.1.

The Florida Middle Ground is a 153,600 ha (379,392 ac) hard bottom area 160 km west-northwest of Tampa, Florida. This region is characterized by steep profile limestone escarpments and knolls rising 10 to 13 m above the surrounding sand and sand-shell substrate, with overall depths varying from 26 to 48 m (Smith 1976). However, although the Florida Middle Ground provides a high–relief substrate for reef biota, its location is apparently too far northward to allow the establishment of massive hermatypic coral assemblages (see Section 3.2.2.2.1).

Madison-Swanson is a 298 square km (115 square mile) area, south of Panama City, Florida, containing high-relief hard bottom habitat, and is a known spawning ground for gag and some other reef fish species (http://oceanexplorer.noaa.gov/explorations/islands01/log/jun20/jun20.html). Depths run between 60 and 100 meters, with habitats ranging from low-relief drowned patch reefs (0.5-2.5 m vertical relief) to high-relief ridges and pinnacles (9-16 m vertical relief). Substrate fauna includes encrusting sponges, sea fans, corkscrew sea whips, *Oculina* coral, and coralline algae. Among the invertebrates found there are galatheid and goneplacid crabs, arrow crabs, crinoids, hermit crabs, basket stars, and squid. Fish species inhabiting Madison-Swanson include gag, scamp, tilefish, amberjack, snowy grouper, red snapper, short bigeyes, rough-tongued bass, batfish, red barbier, reef butterflyfish, and bank butterfish. Another known spawning ground for gag and other reef fish species is Steamboat Lumps, which is a low-relief area of 269 square km (104 square miles), located west of Tarpon Springs.

The Dry Tortugas refers to a roughly 480 square nm area of carbonate banks situated in open ocean, approximately 70 miles west of Key West, and 140 miles from mainland Florida. One of the banks is emergent with seven small, sandy islands (GMFMC 2000). The banks define a roughly circular pattern and were described by Vaughan (1914) as an atoll. The shallow rim of the atoll is discontinuous and consists of Holocene (<10,000 years old) coral and the sandy islands. The Holocene reefs are approximately 14 m thick, and are situated upon an antecedent high of the Key Largo Limestone, formed approximately 125,000 years ago (Shinn *et al*. 1977).

Two significant carbonate banks are situated in close proximity to the Dry Tortugas, known as Tortugas Bank and Riley's Hump. Tortugas Bank is directly west of the Dry Tortugas reefs, separated by a northeast-southwest trending channel. The channel is about 34 m deep and five kilometers wide. The bank has a 30 m escarpment on the west, a 15 m face on the east, and crests at approximately 20 m. Studies indicate that Tortugas Bank is contemporary with the outlier reefs seaward of the Keys reef tract (Lidz *et al*. 1991; Ludwig *et al*. 1996).

Riley's Hump is a carbonate bank situated south-southwest of the Tortugas Bank. Based on its position, it is estimated to be equivalent in age to the Florida Middle Grounds (GMFMC 2000). It crests at about 30 m, and the southern face exhibits a 20 m escarpment situated at the shelf/slope break. Thick sedimentary deposits fill a trough separating Riley's Hump from Tortugas Bank.

Hine *et al*. (1998) used acoustic surveys to update information about the west Florida Shelf. Acoustic surveys demonstrated that the west Florida inner continental shelf is dominated by a Cenozoic limestone bedrock unconformity supporting a thin, mixed siliciclastic/carbonate sedimentary veneer. The unconformity has various spatial scales of antecedent relief: (1) pits, depressions, ledges from cm to several m of relief and cm to 100s m in width/length, to (2) broad rise, flat bedrock plain, and shelf valleys from m of relief to km in width/length. The sedimentary cover is commonly arranged in: (1) linear ridges ranging 0.5 to 4 m of relief, 10s m in width, 100s m of spacing, and km in length, (2) broad, very thin sheets, or (3) active ebb-tidal deltas located just off tidal inlets.

Ongoing mapping allowed definition of distinct areas or shelf provinces that transition from one to another both alongshore and onshore/offshore. In addition, shelf provinces can be distinguished by either their surface characteristics, their subsurface characteristics or both. For example, a subsurface shelf valley may support a relatively featureless sandy plain or a sediment ridge complex.

Hine at al. (1998) defined the following provinces:

Bedrock Rise/Linear Sand Ridges (Indian Rocks Headland)
Estuarine Retreat Path (Tampa Bay)
Shelf Valley (off Manatee County and Venice)
Sand Ridge Plain (off Sarasota County)
Sediment Barren Bedrock Terrace (off Venice)

Some of these provinces have significant onshore/offshore trends as well as the north to south trends seen above. For example, the shelf valley systems have smaller relief going offshore. In contrast, the shelf sand ridges off Indian Rocks and Sarasota increase in relief going seaward. However, close to the nearshore, the sand ridges seem to disappear altogether suggesting that they do not provide sediment to the beach.

The link between coastal sectors and adjacent shelf provinces ranges, from a strong direct link in the Indian Rocks Beach area and the Tampa Bay mouth area, to no apparent link at all in the Sarasota/Venice area. For example, the bedrock rise supporting the linear ridges off Indian Rocks Beach is the direct seaward extent of the coastal headland. Antecedent rock topography controls both coastal headland and inner shelf geology. Similarly, the estuarine retreat path of Tampa Bay has left a featureless sediment plain that transitions into a swash-bar dominated, relatively new barrier island system covering open estuarine deposits. The coastal system south of Tampa Bay seems to have no large-scale morphologic relationship to the adjacent inner shelf provinces. However, most likely there are local direct links between barrier island/inlet morphology and underlying antecedent rock topography.

Little linkage between modern shelf processes and shelf provinces suggests that the shelf provinces are a product of the geologic past, having inherited large-scale properties such as regional bedrock topography, valley infill, and uneven sediment cover from long-term processes such as subterranean and surface dissolution, paleofluvial activity, climate change, and sea-level fluctuations.

3.1.1.4 The Mississippi-Alabama shelf

The Mississippi-Alabama Shelf is a small area extending from the Mississippi River Delta to DeSoto Canyon. The sediments found here are terrigenous to the west, integrating to carbonate sediments near DeSoto Canyon. The outer shelf is dominated by topographic features, which represent the remains of ancient reef or shoreline structures. Ludwick and Walton (1957) were the first to investigate the bottom irregularities found on the shelf and shelf break off the coasts of Alabama and Mississippi. They termed these low-relief hard bottom features “pinnacles.” These pinnacles are made of hard, rigidly-cemented, irregularly-shaped aggregates of calcareous organic structures (Continental Shelf Associates, Inc. 1992). It has been speculated that the pinnacles along the Mississippi-Alabama shelf/slope originated as reefs during lower sea level stands. They are no longer growing but occupy an intermediate position between growth and fossilization.

These calcareous shelf edge and upper slope prominences are present in a wide band (approximately 1.6 km) along the shelf edge from 85° to 88° W longitude (Ludwick and Walton 1957). They found the average pinnacle height to be 9 m with some pinnacles exceeding 15 m in relief and the average water depth to the top of the pinnacles to be 99 m. The average water temperature corresponding with this depth was 17.3° C (63 ° F) and the average salinity was 37 ppt. Pinnacles ranged in water depths from 102 to 179 m and water depths to the top of the pinnacles were found in two zones. In the shallower zone, the depth to the top of the pinnacles ranged from 68 to 84 m and in the deeper zone the depth to the top of the pinnacles ranged from 97 to 101 m. The greatest number of pinnacles was in water depths of 102 to 113 m.

Ludwick and Walton (1957) found the most common organic constituents of their sediment samples within the pinnacle area to be calcareous algae, gastropods, stony corals and bryozoans. All of the calcareous algae collected were red algae (Rhodophyta). Although none of the algae were found alive, the algae did constitute up to 75 percent of the sediments within the pinnacle area. The presence of the algae suggests formation in water depths considerably shallower than those near the pinnacles today.

Hard bottoms are located in several locations on the inner continental shelf adjacent to Florida and Alabama, in depths of 18 to 40 m (Schroeder *et al*. 1988a). These hard bottom areas lie south of the mouth of Mobile Bay and south of the Alabama/Florida state line. They have a vertical relief of 0.5 to 5 m. Schroeder *et al*. (1988a) identified these areas as either 1) massive to nodular sideritic sandstones and mudstones, 2) slabby aragonite-cemented coquina and sandstone, 3) dolomitic sandstone occurring in small irregular outcrops and 4) calcite-cemented algal calcirudite occurring in reef-like knobs. Hard bottom formations were aligned parallel to the shoreline, which suggests a connection with paleo-shoreline positions (Schroeder *et al*. 1988a). Brooks (1991) found these shallow water hard bottoms off Mobile Bay to support living algae. These particular shallow water outcrops also serve as spawning areas for certain fish, such as spot, *Leiostomus xanthurus*, and Atlantic croaker, *Micropogonias undulatus*.

The Southeast Banks area lies south-southeast of the mouth of Mobile Bay, approximately 28 km offshore in water depths of 21 to 26.5 m. Southeast Banks consists of a rock rubble field with 4 m of relief on a moderately sloping bottom of shell hash and silty sand (Schroeder *et al*. 1988a). The Southwest Rock area is located southwest of the mouth of Mobile Bay, approximately 17 km south of Dauphin Island in water depths of 20 to 22 m (Schroeder *et al*. 1988a). Southwest Rock consists of a rock outcrop, 7 to 9 m across, that rises 1 to 1.5 m above a smooth bottom of muddy sand. A smaller outcrop, approximately 1.5 to 3.5 m across, is located 10 m to the southwest. Epifauna included mostly barnacles, serpulids, and bryozoans (Schroeder *et al*. 1988a). Near Southwest Rock is a site that encompasses a gently sloping ridge that trends north-northwest to south-southeast and has 1 to 1.5 m of relief (Schroeder *et al*. 1988a). The 17 Fathom Hole area is located approximately 37 km south of Mobile Bay in water depths of 30 to 32 m. The 17 Fathom Hole is a depression consisting of small rock rubble, shell, and coarse sand with relief of 5 m (Schroeder *et al*. 1988a). The Big Rock/Trysler Grounds area is located approximately 46 km offshore of the Alabama-Florida state line in water depths of 30 to 35 m. Big Rock consists of a large mound feature with 5 m of relief (Schroeder *et al*. 1988a). The Trysler Grounds consists of small rocks with relief of 2 to 3 m on an irregular bottom (Schroeder *et al*. 1988a). The 40 Fathom Isobath area is located 24 km northeast of the pinnacles area, in water depths of approximately 75 m. This area consists of topographic features with up to 9 m of relief, that are either mound-like, pinnacle-like, or ridge-like in form (Schroeder *et al*. 1988b).

Continental Shelf Associates, Inc. (CSA 1992) investigated another portion of the Mississippi-Alabama continental shelf west and north of the areas investigated by Brooks (1991). Three types of hard-bottom features were identified for biological characterization:

(1) pinnacle features present in approximately 80- to 90-m water depths;

(2) deepwater pinnacles and associated hard bottom located in approximately 110- to 130-m water depths; and

(3) suspected low relief, hard-bottom features in the central and eastern portions of the upper Mississippi-Alabama shelf in water depths shallower than 75 m. Although the CSA biological investigations were fairly limited, they did study several significant topographic features.

Shinn *et al*. (1993) investigated an exploratory drill site in Main Pass Block 255. The drill site was located at 103-m water depth and was adjacent to a 4- to 5-m high rock pinnacle. In 1994, DelMar Operating Inc. re-investigated the disturbed site in Main Pass Block 255. Their findings (DelMar Operating, Inc. 1994) are summarized below:

> Locally the 330' (100 m) isobath appears to be the lower limit of any exposed carbonate material, regionally, the 390' (120 m) isobath appears to be the lower limit regardless of pinnacle or mesa-like characteristics. Associated with the mesa-like features are carbonate RLM [reef-like mounds]. These RLM are typically less than 20-feet in length, 3-feet in height, and 4-feet in breadth.
>
> Throughout the area north and east of the existing template, the slope trends are locally interrupted by several RLM. The most significant seafloor feature in the site-specific area is the carbonate material at the edge of the mesa-like feature and the moderate slope break that it defines. Within this zone, several RLM can be identified sitting above the general local bathymetric trend. Current analysis of the RLM and the mesa-like features located throughout the region indicate that all of these features are believed to be more common than originally mapped.

West of the pinnacles area, Sager *et al*. (1992) examined a multitude of topographic features that can be divided into three classes. The first are reef-like mounds that are widespread in water depths shallower than 120 m, and are often clustered. The smallest reef-like mounds are 1 to 2 m in diameter, providing 1 to 2 m of relief. Sager *et al*. (1992) found several fields with high densities of small reef-like mounds (3,500 to 7,000 per km^2), 10 to 15 m across and 2 to 5 m in relief. The largest reef-like mounds are 500 to 1,000 m in diameter with heights of 3 to 18 m. Most reef-like mounds are in water depths of 74 to 82 m in a band that trends from the southwest to the northeast. Many reef-like mounds were found in shallower areas (60 to 70 m) and in deeper waters (87 to 94 m). The reef-like mounds appear to be calcareous bioherms inhabited by crustose coralline algae, *Lithothamnium* and *Peyssonnelia*, serpulid worm tubes, bryzoans, foraminifera, and isolated hermatypic corals, *Stephanocoenia* and *Agaricia* (Sager *et al*. 1992).

The second type of topographic feature examined by Sager *et al*. (1992) were ridges that run parallel to the depth isobaths and have widths of tens to hundreds of meters and lengths of up to about 15 km. Most are within a narrow depth range of 68 to 76 m, sometimes occurring in bands of up to 6 to 8 small ridges. The ridges exhibit low relief with heights of about one meter. The largest ridge examined had a height of 8 m (Sager *et al*. 1992).

The last type of topographic feature studied by Sager *et al*. (1992) was the shallow depressions that are generally 10 to 15 m or less in diameter and a meter or less in depth. In the western part of the area surveyed by Sager *et al*. (1992), large numbers of the depressions were found clustered (1 to 80 per km^2) in several areas. These areas are also very similar to those described by Shipp and Hopkins (1978) on the northern rim of DeSoto Canyon 25 km offshore near Pensacola, Florida. The rim of DeSoto Canyon consists of continuous ridges of granular limestone outcroppings oriented from east-northeast to west-southwest. The outcroppings were composed of one to three ridges, each bordered by sandy flats. The ridges were approximately 20 m wide. The relief of the ridges varied from barely detectable along the northeast segment to nearly 10 m along the southwestern extremity of the canyon. Further to the southwest, the ridges become discontinuous but form numerous ledges of 10 to 15 m relief.

A four-year study (1996-2000) characterizing and monitoring carbonate mounds on the Mississippi/Alabama outer continental shelf (OCS) was recently completed by Continental Shelf Associates, Inc. and the Geochemical and Environmental Research Group (GERG) of Texas A&M University (TAMU) for the U.S. Geological Survey (USGS), Biological Resources Division (CSA and GERG, 2001). Five of the nine sites investigated during the four-year project are located in the Central Planning Area of the Gulf of Mexico and could potentially be affected by lease sale; the remaining 4 sites are outside the lease sale area and will not be affected. The geographic features of the five areas investigated by CSA and GERG that are included in this multisale EIS are described as follows:

- Site 5 includes high relief with a tall, flattop mound near its center and a lower mound at its southwestern edge; a horseshoe shaped (100-m base diameter), medium-profile, flattop structure, with 8-m maximum relief and a base depth of 77 m . A fine sediment veneer occurred on all horizontal rock surfaces and was particularly evident on the top of the feature, filling all depressions. This pinnacle feature is known as Double-Top Reef and belongs to the shallow pinnacle trend in the central and northeastern Gulf of Mexico.
- Site 6 is a low-relief site covering part of a large, carbonate hard ground consisting of extensive areas of low-relief rock features. The features range up to about 1 m in height on a relatively flat seafloor and covered with a thin layer of fine sediments.
- Site 7 is a high-relief site located on a large, flat top mound. Known as "Alabama Alps," this pinnacle feature forms the northwestern terminus of a northwest to southeast aligned ridge and pinnacle arc paralleling the shelf edge (USDOI MMS, 2000a). The sides of the feature range from nearly vertical walls stepping down to the seafloor to large attached monolithic structures that decrease in height farther from the site center. Along the western side of the site, there are numerous large rock overhangs and ledges several meters wide and deep, with some tilted at acute angles. Large, distinct sediment-filled depressions and channels were observed along the southern edge of the monitoring site.
- Site 8 is a medium-relief site with a rugged mound near its center and numerous crevices and overhangs associated with the feature. The mound is slightly elongated, approximately 40 m in north-south extent and 15 m in east-west extent, with a smaller mound located nearby to the east. The relief of the smaller mound is

7-8 m above the surrounding seafloor. The entire feature is covered by silt with areas of thicker deposits on horizontal surfaces and in depressions and crevices.

- Site 9 is low relief consisting of low subcircular mounds, generally 0.5-2 m in height with diameters of 5-20 m. There are a few features with up to 5-m relief with ledges, overhangs, and crevices. A few outcrops are much larger with heights up to 5 m and diameters greater than 10 m. Many of the medium to large structures are flattened and greatly undercut with wide overhangs and vertical holes down through the mounds. The bases of the features are covered with silt up to a height of about 0.5 m. Some areas of low rock are completely covered and the buried hard substrate is only apparent from the gorgonian fans and whips protruding through the silt.

Mobile Bay and estuaries along the Gulf of Mexico margin typically originate as incised fluvial valleys that formed during the most recent drop in sea level, and were then drowned by the subsequent post-glacial sea-level rise (Kindinger 1996). Most of these estuaries have been filling with sediment from fluvial and marine sources. The Mississippi-Alabama shelf province is defined by characteristics resulting from deltaic deposition advancing and receding as sea level rose and fell.

During the recent geologic history of the Mississippi-Alabama shelf area, river mouths, such as that of the Mobile River, alternately incised and flooded as the sea transgressed and regressed because of sea-level changes of as much as 90 feet. Over the past 4,000 years, many of the incised river valleys filled with estuarine muds, while the nearshore marine environment saw the formation of sandy shoals and barrier beaches. As sea level rose, these accumulations of sand migrated shoreward while wave action spread the sand along the shore. During regressions, however, sand bodies moved seaward and tended to be covered by muds and other fine sediments of quieter estuarine environments. Currently, the Mobile Bay area is tectonically stable, as deposition of Mobile River sediments is not causing subsidence (Schroeder DISL personal communication).

3.1.1.5 Louisiana-Texas shelf

The Mississippi River has had a profound effect on the landforms of coastal Louisiana (Louisiana Coastal Restoration no date). The entire area is the product of sediment deposition following the latest rise in sea level about 5,000 years ago. Each Mississippi River deltaic cycle was initiated by a migration of the main distributory channel that offered a shorter route to the Gulf of Mexico. After abandonment of an older delta lobe, which would cut off the primary supply of fresh water and sediment, an area would undergo compaction, subsidence, and erosion. The old delta lobe would begin to retreat as the Gulf advanced, forming lakes, bays, and sounds. Concurrently, a new delta lobe would begin its advance gulfward. This deltaic process has, over the past 5,000 years, caused the coastline of south Louisiana to advance gulfward from 15 to 50 miles, forming the present-day coastal plain.

For the last 1,200 years, sediment deposition has occurred primarily at the mouth of the Mississippi River, in the area defined as the Mississippi River Delta Basin (Louisiana Coastal Restoration, no date). This delta is located on the edge of the continental shelf of the Gulf of

Mexico. Its “bird's foot” configuration is characteristic of alluvial deposition in deep water. In this configuration large volumes of sediment are required to create land area; consequently, land is being lost in this delta more rapidly than it is being created.

The Louisiana shelf varies in width from less than 20 km off the passes of the "birdfoot" delta to nearly 200 km off central and western LA with little dramatic changes in topographic relief (Louisiana Coastal Restoration, no date). There is a tremendous fine-grain sediment load from the Mississippi River. The western portion of this shelf receives much less sediment, and instead has Holocene muds up to 10 m thick. There are carbonate banks present, created during times of low sea level.

About 500 km upstream from its main outlet to the Gulf of Mexico, the Lower Mississippi River is partly diverted into the Atchafalaya River. About one-fourth, on average, of the water that flows down the Mississippi River past Vicksburg is diverted to join the waters of the Red and Ouachita Rivers in forming the Atchafalaya River (Meade 1995). The two outlets of the Mississippi River eventually discharge a combined average of 580 cubic kilometers per year (or about 420 billion gallons per day) of freshwater to the Gulf of Mexico. This discharge ranks seventh in the world, being exceeded only by those of the Amazon, Congo (or Zaire), Orinoco, Yangtze, the combined Ganges-Brahmaputra, and Yenisey Rivers.

Not all parts of the Mississippi River drainage basin contribute water in equal measure (Meade 1995). Nearly one-half the water discharged to the Gulf is contributed by the Ohio River and its tributaries (including the Tennessee); these combined drainage areas constitute only one-sixth of the total area drained by the Mississippi. By contrast, the Missouri River drains 43 percent of the total area but contributes only 12 percent of the total water.

The Mississippi River now discharges an average of about 200 million metric tons of suspended sediment per year past Vicksburg and eventually to the Gulf of Mexico (Meade 1995). This sediment discharge to the ocean ranks about sixth in the world. The annual and seasonal fluctuations in sediment loads correspond to fluctuations in water discharge. The suspended-sediment loads carried by the Mississippi River to the Gulf of Mexico have decreased by one-half since the Mississippi Valley was first settled by European colonists. This decrease began in 1928 as levee systems were constructed and continued as other water control projects were developed through 1963. The largest natural sources of sediment in the drainage basin were cut off from the Mississippi River main stem by the construction of large reservoirs on the Missouri and Arkansas Rivers. This large decrease in sediments from the western tributaries was counterbalanced somewhat by a five- to tenfold increase in sediment loads in the Ohio River-an increase that has resulted from deforestation and row crop farming.

The Missouri River has been the principal supplier of sediment to the Mississippi River since the end of the last ice age (Meade 1995). After five large dams were completed for hydroelectric power and irrigation above Yankton, South Dakota, between 1953 and 1963, the discharge of sediment from the Upper Missouri River Basin was virtually stopped. Following the closure of Fort Randall Dam and Gavins Point Dam in 1953, down-river sediment discharges were diminished immediately, and the effect could be observed all the way down to the mouth of the

Mississippi River. Sediment discharges to the Gulf of Mexico in 1992 were less than one-half of what they were before 1953.

Despite the controls on water flow and sedimentation that are provided by dikes and other engineering works, some reaches of the river require periodic dredging to maintain the depth of water necessary for navigation. In the Lower Mississippi, the dredged material is frequently piped out to the fast flowing part of the river to be discharged (Meade 1995). In the Upper Mississippi, where sand is frequently the material dredged, large spoil banks and artificial islands have been built alongside the main navigation channel.

The Louisiana/Texas Shelf is dominated by muddy or sandy, terrigenous sediments deposited by the Mississippi River. These terrigenous sediments cover over 3,000 m of rock salt (Louann Salt) that has been deposited since the formation of the Gulf of Mexico basin. Nearly 15 km of sediment cover the Louann salt deposit south of the Louisiana/Texas state line. This huge sediment load has caused the deposits of salt to flow and form diapirs that now dot the inner shelf and adjacent coastal plain. Many large isolated salt stacks interconnected by intricate networks of growth faults characterize the middle shelf and lower Mississippi River delta region. More than 130 calcareous banks exist as a result of active diapirism in the northwest Gulf of Mexico (MMS 1983).

Rezak *et al*. (1985) conducted extensive research on the banks and reefs of the northwestern Gulf of Mexico. They grouped the banks into two categories. The first are the mid-shelf banks, defined as those that rise from depths of 80 m or less and have a relief of 4 to 50 m. They are similar to one another in that all are associated with salt diapirs and are outcrops of relatively bare, bedded Tertiary limestones, sandstones, claystones, and siltstones. Some of the named mid-shelf banks are Sonnier Bank, Fishnet Bank, Claypile Bank, 32 Fathom Bank, Coffee Lump, Stetson Bank, Phleger Bank, and 29 Fathom Bank. Shelf-edge banks include the well known East and West Flower Garden Banks, and the lesser known McNeil, Bright Rezak, Geyer, Mcgrail, Alderice, and Jakkula Banks.

The continental shelf south of Matagorda Bay, Texas contains an area of drowned reefs on a relict carbonate shelf (Rezak *et al*. 1985). These carbonate structures, the remains of relict reefs, currently only support minor encrusting populations of coralline algae. The banks vary in relief from 1 to 22 m. The sides of these reefs are immersed in a nepheloid layer that varies in thickness from 15 to 20 m (Rezak *et al*. 1985). The sediments around the reef consist of three main components, including clay, silt, and coarse carbonate detritus. These banks are composed of carbonate substrata overlain by a veneer of fine-grained sediment around the base that reaches an approximate thickness of 20 cm. These fine-grained sediments decrease to a trace on the crests. Carbonate rubble is the predominant sediment on the terrace and peaks of the banks.

Several shallow water reefs also occur on the south Texas shelf. These reefs are East Bank, Sebree Bank, Steamer Bank, Little Mitch Bank, Four Leaf Clover, 9 Fathom Rock, and Seven and One-half Fathom Reef. These reefs are located south of Corpus Christi down to Brownsville in water depths of 14 to 40 m and provide relief of up to 5 m. These reefs are thought to have different origins from the other banks located farther offshore on the south Texas shelf.

Southern Bank is a typical example of the relict reefs found on the south Texas shelf. It is circular in view with a diameter of approximately 1,300 m, and rises from a depth of 80 m to a crest of 60 m (Rezak *et al*. 1985). Approximately fourteen banks are on the south Texas shelf in water depths ranging from 60 to 90 m. The named south Texas banks are Big Dunn Bank, Small Dunn Bank, Blackfish Ridge, Mysterious Bank, Baker Bank, Aransas Bank, Southern Bank, North Hospital Bank, Hospital Bank, South Baker Bank, Sebree Bank, Big Adam Bank, Small Adam Bank, and Dream Bank.

Because of their relatively low relief above the surrounding mud bottom, the southernmost mid-shelf carbonate banks on the south Texas shelf apparently suffer from chronic high turbidity and sedimentation from crest to base, and all rocks are heavily laden with fine sediment (Rezak *et al*. 1985). Consequently, the epibenthic communities on these banks are severely limited in diversity and abundance.

3.1.2 Oceanographic features

3.1.2.1 Water

The Gulf of Mexico is a semi-enclosed, oceanic basin connected to the Atlantic Ocean by the Straits of Florida and to the Caribbean Sea by the Yucatan Channel. Although its surface area is more than 160 million ha (395 million ac), it is a small basin by oceanic standards. Most of the oceanic water entering the Gulf flows through the Yucatan Channel, a narrow (160 km wide) and deep (1,650-1,900 m) channel. Water leaves the Gulf through the Straits of Florida, which is about as wide as the Yucatan Channel, but not nearly as deep (about 800 m). This pattern of water movement produces the most pronounced circulation feature in the Gulf of Mexico basin, known as the Loop Current with its associated meanders and intrusions. After passing through the Straits of Florida, the Loop Current, also known as the Florida Current at this stage, merges with the Antilles Current to form the Gulf Stream.

Runoff from precipitation on almost two-thirds of the land area of the U.S. eventually drains into the Gulf of Mexico via the Mississippi River. The combined discharge of the Mississippi and Atchafalaya Rivers alone accounts for more than half the freshwater flow into the Gulf and is a major influence on salinity levels in coastal waters on the Louisiana/Texas continental shelf. The annual freshwater discharge of the Mississippi/Atchafalaya River system represents approximately 10 percent of the water volume of the entire Louisiana/Texas shelf to a depth of 90 m. The Loop Current and Mississippi/Atchafalaya River system, as well as the semi permanent, anticyclonic gyre in the western Gulf, significantly affect oceanographic conditions throughout the Gulf of Mexico.

3.1.2.2 Temperature

The physical characteristics of the Gulf of Mexico have been extensively mapped. Darnell *et al*. (1983) mapped physical parameters for the northwestern Gulf of Mexico (the Rio Grande River to the Mississippi River). Bottom temperature was mapped for the coldest and warmest months (January and August). During January, the shallowest waters of the central shelf ranged between 12° C (54° F) and 14° C (57° F). The temperature increased with depth, with a broad band of warmer water, between 17° C (63° F) and 19° C (66° F), across the middle to deeper shelf. However, on the outer shelf off central Louisiana and south Texas, temperatures dropped below 17° C (63° F), presumably due to the intrusion of cold deeper waters in both areas.

During August, the shallowest waters of the central shelf reached 29° C (84° F), and bottom water temperatures decreased almost regularly with depth, attaining lows of around 17° C (63° F) to 18° C (64° F) toward the outer shelf. Thus, bottom temperatures showed a seasonal range of 15° C (27° F) or more, but on the outer shelf the seasonal range was only 2° C (3.6° F) or less. Clearly, the middle to outer shelf waters could provide a haven for nearshore warm water species during the winter months, and for offshore species it is inhabitable the year round.

Darnell and Kleypas (1987) mapped the eastern Gulf of Mexico (Mississippi River to the Florida Keys), following the same protocol as Darnell *et al*. (1983) in gathering bottom temperature data during January and August. During the months of January, the coldest shelf water (14° C (57° F)) appeared just off the Mississippi barrier islands. Water colder than 16° C (61° F) occupied the nearshore shelf out to the 25-m isobath from the Chandeleur Islands to Cape San Blas, Florida, and below that point it extended to the 20-m isobath to northern Tampa Bay. West of DeSoto Canyon all bottom shelf waters were below 18° C (64° F). However, east of DeSoto Canyon, all outer shelf waters exceeded 18° C (64° F), and the 18° C (64° F) and 20° C (68° F) isotherms passed diagonally shoreward across the isobaths so that all shelf waters from just above Charlotte Harbor to the Florida Keys were 18° C (64° F) or above. The maximum January temperature (22° C (72 ° F)) was encountered near the southern tip of the Florida shelf at a depth of 60 m to 70 m.

During August, the temperature of the nearshore bottom water ranged from 26° C (79° F) near Panama City, Florida, to 30° C (86° F) around Cedar Keys, Florida. Throughout the eastern Gulf shelf, bottom water temperatures decreased with depth. Near the Mississippi River Delta the outer shelf water was 22° C (72° F), but temperatures down to 16° C (61° F) were observed along both the eastern and western rims of DeSoto Canyon and at several localized areas along the outer shelf of Florida. For most of the shelf of the Florida peninsula, bottom isotherms paralleled the isobaths.

Seasonal comparisons reveal that nearshore waters for the entire eastern Gulf shelf were 10° C (50° F) to 15° C (59° F) warmer in the summer than in the winter. Near the Mississippi River Delta, the bottom waters of the outer shelf were only about 5° C (9° F) warmer in the summer than during the winter. However around the rim of DeSoto Canyon and along the shelf of Florida, summer temperatures ranged 1° C (1.8° F) to 4° C (39° F) colder in the summer than in the winter. This summer temperature depression is due to the intrusion of colder slope water onto the outer shelf during the summer months.

Surface temperatures for the entire Gulf of Mexico were reported by NOAA (1985). Surface temperatures were measured in January and July. During January, temperatures ranged from 14° C (57 ° F) to 24° C (75 ° F). MMS (1997) found surface temperatures in the Gulf of Mexico in January to range from 25° C (77 ° F) in the Loop current core to 14° C (57 ° F) to 15° C (59 ° F) along the shallow northern coastal estuaries. NOAA (1985) found the coldest water along the Louisiana/Texas border on the upper shelf. The warmest was found off the southwestern tip of Florida. Temperatures gradually increased with distance from shore in the entire Gulf. Temperatures also increased southward on the Florida peninsula with temperatures ranging from 16° C (61 ° F) to 24° C (75 ° F) north to south.

Surface temperatures in July ranged from 28° C (82 ° F) to 30° C (86 ° F) (NOAA 1985). The coolest water was found off the south Texas coast. The warmest water was found off the Mississippi/Alabama coast, the Big Bend area of Florida, and the southern tip of Florida. Temperatures gradually decreased with distance from shore. Surface temperature reported from SEAMAP cruises during July (Donaldson *et al*. 1997) ranged from 28° C (82 ° F) to 31° C (88 ° F). The warmest water was found around the Florida Keys. The coolest water was found off the Big Bend area of Florida, while most of the Gulf had surface temperatures of 29° C (84 ° F). These temperatures agree closely with MMS (1997) data showing 29° C (84 ° F) to 30° C (86 ° F) water throughout the Gulf during August.

3.1.2.3 Salinity

Surface salinities in the Gulf of Mexico vary seasonally. During months of low freshwater input, surface salinities near the coastline range between 29 and 32 ppt (MMS 1997). High freshwater input conditions during the spring and summer months result in strong horizontal salinity gradients with salinities less than 20 ppt on the inner shelf. The waters in the open Gulf are characterized by salinities between 36.0 and 36.5 ppt (MMS 1997).

Bottom salinities were measured by Darnell *et al*. (1983) for the northwestern Gulf during the freshest and most saline months, May and August, respectively. During May, all the nearshore waters showed salinity readings of 30 ppt or less, and for all of Louisiana and Texas to about Galveston Bay, salinity of the nearshore water was less than 24 ppt. Water of full marine salinity (36 ppt) covered most of the shelf deeper than 30 m to 40 m. During August the only water of less than 30 ppt was a very narrow band in the nearshore area off central Louisiana. The 36 ppt bottom water reached shoreward to the 20 m to 30 m depth off Louisiana, but in Texas the entire shelf south of Galveston showed full marine salinity. The shallower shelf bottom waters off Louisiana tend to be fresher than those off Texas during both the freshest and most saline months, but the difference is not great, and brackish water extends no deeper than about 30 m. Bottom waters of the mid to outer shelf remain fully marine throughout the year. Thus, it would appear that the freshening influence of the Mississippi and Atchafalaya Rivers is restricted primarily to the surface layers.

In the eastern Gulf, Darnell and Kleypas (1987) found that during May the bottom salinity of the nearshore water varied locally. From Tampa Bay to the Mississippi River Delta the salinity of the nearshore water was 35 ppt or less with a low value of 33 ppt above Cedar Keys and off the coasts of Alabama and Mississippi. The lowest reading (31.5 ppt) occurred just off the Mississippi barrier islands. Below Tampa Bay all nearshore water was 36 ppt except locally off Charlotte Harbor and the Everglades. Bottom water of about 33 ppt characterized the entire shelf off Mississippi and Alabama, and tongues of fresher water extended from the Mississippi River Delta along the outer shelf. Water of full marine salinity covered the margins and head of DeSoto Canyon, and on the Florida shelf it ran diagonally shoreward to Tampa Bay. The highest salinity (36.5 ppt) appeared at mid-shelf above the outer Keys of south Florida.

The same pattern prevailed in August. From Tampa Bay to the Mississippi River Delta the shore water was 35 ppt or less. A pocket of 32 ppt water appeared near Cedar Key, and off most of Alabama and Mississippi the water was 34 ppt or less. Below Tampa Bay all nearshore water was 36 ppt or greater except for a small extension of slightly fresher water from Charlotte Harbor. The entire shelf off Mississippi and Alabama had bottom water of less than 36 ppt, and tongues of fresher water protruded eastward from the Mississippi River Delta along the middle and outer shelf. Salinities of 36 ppt and above characterized the area around the rim of DeSoto Canyon and, with undulations, ran diagonally shoreward to Tampa Bay. Salinities in excess of 36 ppt appeared at several areas along the outer half of the Florida shelf, and higher salinity water extended across much of the shelf off the Everglades and above the Keys.

The salinity patterns reflect heavier river outflows in the Louisiana, Mississippi, Alabama area especially during the spring, and lower freshwater outflow from the streams of Florida. The patterns also reflect the movement of open Gulf water over the lower half of the Florida shelf and intrusion of slope water around DeSoto Canyon and along the outer shelf of Florida. Freshwater springs occur at several locations on the Florida shelf.

3.1.2.4 Dissolved oxygen and hypoxia

Dissolved oxygen values in the Gulf of Mexico average about 6.5 ppm, with values averaging about 5 ppm during the summer months (Barnard and Froelich 1981). Areas of anoxic bottom water have not been reported from the eastern Gulf continental shelf. However, summer hypoxia of bottom water has been noted for Mobile Bay and Tampa Bay. Areas of excessively low bottom oxygen values (less than 2.0 ppm) have long been known to occur off central Louisiana and Texas during periods of stratification in the warmer months. Oxygen deficient conditions occur primarily from April through October and may cover up to 1.82 million ha (4,495,400 ac) during the midsummer with the location and extent varying annually (Rabalais *et al*. 1997).

A large zone of oxygen-depleted water extends across the Louisiana continental shelf and on to the Texas coast most summers (Figure 3.1.4). The northern Gulf of Mexico hypoxic zone is the largest such zone in coastal waters of the Western Hemisphere (Rabalais *et al*. 1997). The occurrence of severe oxygen depletion, either hypoxia (< 2 mg/l, or < 3 mg/l in some systems) or anoxia (0 mg/l), is a growing concern for U.S. estuarine and coastal waters. Many hypoxic zones elsewhere in the world have been caused by excess nutrients exported from rivers, resulting in reduced commercial and recreational fisheries. Prolonged oxygen depletion not only disrupts benthic and demersal communities but can also cause mass mortalities of aquatic life (Diaz and Rosenberg 1995). Among other problems, the consequences to coastal commercial fisheries can be disastrous (Baden *et al*. 1990; Zaitsev 1991, 1993). Hypoxic zones are now one of the most widespread and accelerating human-induced deleterious impacts on the world's marine environments. Once again the estimated size of the 'dead zone' off Louisiana and Texas has grown past previous years at 22,000 sq. km (= 8,500 sq. mi.), reports Dr. Nancy Rabalais. The area it stretches across the Gulf of Mexico sea floor is larger than the state of Massachusetts (LUMCON Press Release 2002).

Oxygen depletion results from the combination of several physical and biological processes. On the Gulf of Mexico continental shelf, hypoxia results from the stratification of marine waters due to Mississippi River system freshwater inflow and the decomposition of organic matter stimulated by Mississippi River nutrients (Rabalais *et al*. 1997). As a general rule, the nutrients delivered to estuarine and coastal systems support biological productivity. Excessive levels of nutrients, however, can cause intense biological productivity that depletes oxygen. The remains of algal blooms and zooplankton fecal pellets sink to the lower water column and seabed. The rate of depletion of oxygen during processes that decompose the fluxed organic matter exceeds the rate of production and replenishment from the surface waters, especially when waters are stratified. Stratification in the northern Gulf of Mexico is most influenced by salinity differences year-round, but is accentuated in the summer due to solar warming of surface waters and calming winds. Following a fairly predictable annual cycle beginning in the spring, oxygen depletion becomes most widespread, persistent and severe during the summer months. Hypoxic conditions usually dissipate with the passage of tropical cyclones and cold fronts during the late summer or fall.

Hypoxia in the northern gulf may occur from late February through early October, nearly continuously from mid-May through mid-September, and is most widespread, persistent, and severe in June, July, and August (Rabalais *et al*. 1997). Hypoxic waters can include 20 to 80% of the lower water profile between 5 and 30 m water depth, and can extend as far as 130 km offshore. Throughout its distribution, the impact of hypoxic bottom waters is exacerbated by the release of toxic hydrogen sulfide from sediments.

The surface layer in the northern Gulf of Mexico shows an oxygen surplus during February through July (Justic *et al*. 1993). The oxygen maximum that occurs during April and May coincides with the maximum flow of the Mississippi River. The bottom layer, on the contrary, exhibits an oxygen deficit throughout the year. From January to July the oxygen in bottom waters decreases at an average rate of 0.7 ppm per month, and reaches its lowest value in July (Justic *et al*. 1993). Bottom hypoxia in the northern Gulf of Mexico is most pronounced when the water column is very stable and does not allow mixing to replenish oxygen to deeper water. Further threats caused by hypoxia (dead zones) can be found in Section 3.5.3.2.3.

3.1.2.5 Turbidity

Surface turbidity in the marine environment in the Gulf of Mexico is limited to the areas affected by the major river systems. The Mississippi/Atchafalaya River system deposits the most sediment and has the greatest effect on surface turbidity in the Gulf. Scruton and Moore (1953) studied the Mississippi River plume and its effects on sedimentation during October, November, and December. They discovered that during the low water season, the amount of sediment in suspension in the surface layer near a pass mouth was around 0.260 g/l. This value decreased by approximately two-thirds within 8 km off the mouth in the main direction of current flow. Outside of the mainstream flow within 8 km of the source, the amount of material in suspension was one-twentieth of the value in the pass mouth. High winds blowing over areas of shallow bottom also greatly influence the turbidity. As much as 0.640 g/l of suspended sediment was measured during a storm period where normal values during calm weather and similar low river discharge were no greater than 0.0064 g/l. These values indicate the amount of suspended material that occur and illustrate the great variation that may be found laterally across the plume and with changes in weather conditions.

The long plumes of sediment that extend seaward from the major passes generally remain connected with their source as long as active seaward dissemination of suspended matter is occurring in a specific direction (Scruton and Moore 1953). When the direction of sediment dispersal is altered, isolated areas of turbidity may persist for a time in the distal part of the decaying plume because of low particle settling velocity. At the outer extremity, the plumes blend with the adjacent water and no longer can be distinguished.

Close inshore the high turbidity from the Mississippi River commonly extends through the entire water column with turbidity maxima occurring at the surface and toward the bottom. Farther offshore where color and intensity of turbidity indicate the amount and average grain size of material in the surface layer have decreased, the subsurface waters are also somewhat turbid, but the difference between the waters above and below may be more visible than inshore. Still farther offshore, the interface below the surface stratum becomes more diffuse as vertical mixing progresses, until a distinction ceases to exist.

Wind and currents are the agents responsible for the observed direction of turbidity distribution. In the inshore areas, river velocity carries the freshwater over the more saline water beneath. Tidal currents modify these original surface currents and, aided by the wind, deliver the turbid water to offshore areas. Turbidity introduced into the Gulf of Mexico by the Mississippi River can be moved by the wind and tides in plumes that may extend 105 km seaward from the delta (Scruton and Moore 1953). While Scruton and Moore (1953) only dealt with the Mississippi River Delta, the same type of river, tidal, and wind dispersal of turbidity is thought to occur at the other major rivers whose waters are laden with sediment entering the Gulf.

Another type of turbidity is the layer of turbid water commonly found near the bottom. Called nepheloid layers, these turbid waters occur in the north-central and northwestern Gulf of Mexico when the turbulence of the water is high enough to offset the settling of the sedimentary particles under the influence of gravity. The larger the particles, the more intense the turbulence must be to maintain a suspension. Nepheloid layers are therefore usually composed of silt and clay particles, because only the most energetic flows can maintain a sand suspension.

Along the south Texas continental shelf, Shideler (1981) found that the nepheloid layer thickened offshore to a maximum of 35 m near the shelf break and that the concentration of suspended sediment in the nepheloid layer decreased from a maximum near shore to a minimum at the shelf break. Inorganic detrital minerals dominated the sediment in the nepheloid layer.

Shideler (1981) also found that the nepheloid layer was thinner and had a smaller areal extent in the fall than in the spring. He concluded that the nepheloid layer is generated and maintained by resuspension of muddy seafloor sediment as a result of bottom turbulence.

Rezak *et al*. (1985) studied the nepheloid layer on the Louisiana/Texas shelf from 1979 to 1982. Inshore of the 10-m isobath the water was turbid from top to bottom. Offshore of the 10-m isobath, the top 2 to 3 m of water are turbid with a layer of clear water between the bottom nepheloid layer and the top layer of turbid water. The nepheloid layer at the base of the water column up to 50 km offshore was heavily laden with suspended sediment. The nepheloid layer extends across the shelf in a well-mixed bottom layer 10 to 15 m thick, and spills over onto the continental slope. At the shelf break, the nepheloid layer wells up to more than 25 m in thickness. Rezak *et al*. (1985) concluded that the sediment in the nepheloid layer is kept in suspension over much of the inner shelf by swift currents and turbulence.

The Mississippi/Alabama shelf is very similar to the Louisiana/Texas shelf in that it receives varying amounts of freshwater and silt and clay and has a well-developed nepheloid layer. The west Florida shelf receives little freshwater runoff and little terrigenous sediment. The absence of silt and clay in the sediment provides much clearer water throughout the water column.

3.2 Biological Environment

Many management programs exist to protect particular habitats or species. However, the number of managed species and the complex components and interrelationships of the environment exceed the capability of most state and Federal management and scientific organizations to understand the essential habitat needs of all managed species and their various life stages. In addition, some organisms residing in different bottom types may also modify those habitats (as ecosystem engineers), and be an intimately associated with the habitats and their ecological function (Coleman and Williams 2002). Ecosystem engineers include organisms whose physical morphology adds complexity to the habitat they occur in (autogenic engineers: wetland plants, mangroves, seagrasses, benthic algae, corals, coralline algae) and those which live in habitats and modify them by their behaviors and actions (allogenic engineers: burrowing, boring, and foraging organisms). Thus, ecosystem complexity and the lack of data and information limits the abilities of management agencies to thoroughly identify and protect appropriate habitats.

In general, data collections and comprehensive analyses have been limited to selected species or components of the environment. Several Federal agencies and all state fishery/natural resource agencies have programs underway to expand necessary information.

- NMFS has the lead responsibility for fishery management and protection in the Federal waters of the Gulf of Mexico (9 miles offshore of Texas and the west coast of Florida and 3-miles offshore of the other Gulf states).

- The U.S. Army Corps of Engineers requires permits for many activities in state and Federal navigable waters, and has biological assessment capabilities.

- The Mineral Management Service has a responsibility to assess biological effects of Federally authorized mineral extraction (especially oil and gas) in the Gulf of Mexico.

- The U.S. Geological Service has a biological research division that emphasizes shallow-water processes, and is also engaged in mapping the benthic habitat of the Gulf.

- The U.S. Fish and Wildlife Service has responsibility for: protection and management of marine birds, manatees, sea turtles, and their habitats when on land; review responsibilities under the Fish and Wildlife Conservation Act for Federal activities that may affect habitats in the inland, estuarine and marine environments; direct management of extensive areas of coastal habitat within the National Wildlife Refuge System; and inventorying and mapping wetlands habitat.

3.2.1 Estuarine and nearshore habitats

Estuarine and nearshore habitats (to the 60-foot or 18 m isobath) form a dynamic boundary between the land and deeper water habitats of the Continental Shelf. In the Gulf of Mexico, estuaries contain a complex mosaic of intertidal and subtidal habitats covering about 51,800 square km (20,000 square miles) (Gunter 1967) and 80-90% of the coastline (Emery 1967). Estuaries are places where freshwater and saltwater mix, and this characteristic presents significant challenges to the organisms that live there (Britton and Morton 1989). Although the majority of the species managed by the Gulf Council are classified as reef species, several important species are considered "estuarine dependent", e.g., red drum (*Sciaenops ocellatus*), penaeid shrimp, and the stone crab (*Menippe adina*). These species are prominent predators in several estuarine and nearshore habitats. However, the contribution of estuaries to the productivity of reefs and other offshore habitats and their fisheries cannot be disputed. The intertidal wetlands and seagrass meadows found in estuaries produce large quantities of organic detritus that is exported to both nearshore and deeper water habitats (outwelling; Odum 1980; Williams and Heck 2001) and this source of nutrients and organic material is an important determinant of productivity in many offshore habitats. The benthic community of unvegetated bottoms recycles and regenerates nutrients. Wetlands, mangroves, seagrass meadows, oyster reefs, and coral reefs also provide complex habitat that serves as a refuge and nursery habitat for juveniles of many marine species as well as foraging habitat for adults of some species (Day *et al*. 1989).

The dynamics of the interactive habitat complex represented by the estuarine, nearshore and offshore zones of the Gulf of Mexico appears to be largely controlled by forces external to the system such as river discharges and tides (Darnell and Soniatt 1979). Gunter (1967, 1969) hypothesized that Gulf of Mexico fisheries production was related to estuarine area and river discharge. More recently, strong correlations have been demonstrated between penaeid shrimp yield and wetland area in the Gulf of Mexico (Turner 1977, 1979, 1992, Turner and Boesch 1988). In addition, there is evidence that the standing crop and populations levels of demersal fish species on the Gulf of Mexico continental shelf are influenced by bathymetry, sediments, littoral vegetation and epicontinental waters, which are in turn influenced by estuaries (Day *et al*. 1989). Because of the close coupling between the estuarine/nearshore zone and offshore habitats, habitat degradation and/or loss of habitat or function in estuarine and nearshore habitats, due to natural or anthropogenic factors, may impact productivity in offshore fisheries.

The following sections will describe the predominant habitat types found in the estuarine and nearshore environment of the Gulf of Mexico and the distribution of these habitats for representative areas are depicted in Figures 3.2.3 - 3.2.7. Gulfwide, data from the National Wetland Inventory (NWI) provide the inshore boundary for areas that may be identified as EFH. This boundary is depicted in Figures 3.2.1 (overview map) and Figures 3.2.2(a)– 3.2.2(l). For the landward boundary of EFH, all data identified as marine or estuarine were captured into one GIS overlay[18]. The areas depicted in the dark gray category, titled intertidal estuary displays only those E2 (intertidal estuary) subsystem. All other E (estuarine), R (riverine), L (lacustrine), and M (marine) categories are displayed in white. Non-marine systems such as U (uplands) and P (palustrine marsh) are in light gray category and would not be considered EFH.

3.2.1.1 Submerged aquatic vegetation (seagrasses)

Entire fisheries may depend on production by seagrass habitats (McRoy and Helfferich 1977) particularly subtropical and tropical areas and to a lesser extent in temperate waters (Williams and Heck 2001). Seagrasses are marine vascular plants found in shallow estuaries and some nearshore habitats worldwide (Williams and Heck 2001). Vast expanses of shallow bottom are often covered with plants (meadows) due to their clonal habit. Seven species of seagrasses can be found in Gulf of Mexico estuaries and nearshore areas: shoalgrass (*Halodule wrightii*, also known as *Halodule beaudettei*), clover grass (*Halophila decipiens*, *H. johnsonii*, *H. engelmanni*), manatee-grass (*Syringodium filiforme*, also known as *Cymodocea filiformis*), widgeon grass (*Ruppia maritima*) and turtle grass (*Thalassia testudinum*). Most seagrass meadows include many species of algae. In estuaries, the majority of algal species are epiphytic, but some attached macroalgae may be found on bits of shell or rubble, and others break loose from adjacent habitats and occur as drift algae.

Both seagrasses and macroalgae have been found to be important nursery habitats for numerous fish species (Rydene and Matheson 2003). The relationship between seagrasses and macroalgae depends on the source and concentrations of nutrients. Macroalgae take up most of their nutrients from the overlying water while seagrasses rely primarily on sediment nutrients and endosymbionts. As a result, macroalgae can bloom in estuaries with high nutrient concentrations in the water column. Macroalgal blooms can smother seagrasses and create decomposing mats that displace or kill animals. Some rhizophytic species of algae, such as those in the genus *Caulerpa* mimic seagrasses, growing in dense patches on the bottom of estuaries, but the relative habitat value of these species, compared to the seagrass species they displace, is not known. Representative Figures (3.2.3 - 3.2.7) depict the distribution of seagrasses from the Corpus Christi region of Texas to southern Florida. *Halophila* spp. occurs in perhaps a million acres on the west Florida shelf (NMFS 2000a).

[18] The boundary was developed by the NOAA/NESDIS/NODC/National Coastal Data Development Center using five NWI data sets, one from each Gulf state, Alabama, Florida, Mississippi, Louisiana, and Texas.

Seagrass meadows are highly productive submerged habitats and are extremely valuable because of the multiple roles they play in the mosaic of estuarine and nearshore habitats (McRoy and Helfferich 1977 and many others). Of fundamental importance is the complex structure the leaves, roots and rhizomes provide in both water column and sediments. This structure baffles waves, reduces erosion, and promotes water clarity while increasing bottom area and providing a surface upon which epiphytes and epibenthic organisms can live. Invertebrate abundance is much higher in seagrass beds than in adjacent unvegetated habitats.

The seagrasses, with their epiflora and epifauna, provide a rich nursery with safe refuge and abundant food resources for juvenile invertebrates and fish as well as prime foraging habitat for adults of many fish species. The role of seagrasses as shelter for juvenile fish is most pronounced in subtropical and tropical waters (Williams and Heck 2001). Many fish that are found on reefs during the day forage in adjacent seagrass meadows at night (Zieman 1982).

Seagrasses are linked to other marine and estuarine communities through export of detritus and migration of animals (Williams and Heck 2001). Large quantities of detritus are exported out of meadows to adjacent communities and even far offshore to deep-sea habitats. In estuaries, mats of seagrass detritus result in localized high levels of secondary productivity. In addition, movement of fish between foraging habitats in seagrass meadows back to the protection of reefs or mangroves also results in transfer of nutrients out of the meadows. Not only do seagrasses make substantial contributions to overall estuarine productivity, they play a major role in productivity in nearshore and offshore habitats as well.

3.2.1.1.1 Ecology

The primary determinant of seagrass presence and productivity is light availability, which is determined by the interaction of water depth and water clarity. Severe losses of seagrass habitat have occurred throughout the world as the result of human impacts. Apart from dredging, the primary anthropogenic cause of seagrass loss is reductions in light availability caused by blooms of microscopic algae in the water column that result from discharge of nutrients into estuaries from sewage and industrial wastewater and non-point sources such as agricultural runoff. Seagrass presence and plant community composition is the result of the interplay between sediment characteristics, wave energy, and water depth; which determines exposure and is a factor in light penetration, salinity tolerance and successional stage. Muddy substrates are generally preferred by seagrasses, but both shoalgrass and turtle-grass will grow in sandy substrates. Clover grass will grow in highly polluted areas and nearly liquid mud (den Hartog 1977). Low energy, shallow water areas with restricted circulation are prime areas for seagrass meadow development. Salinity tolerances vary. Shoalgrass tolerates the widest range of salinities, and has the highest optimal range (45 ppt; McMahon 1968). Clover grass has the narrowest range. In general, optimal salinities for the species found in the Gulf range from 20-40 ppt, although widgeongrass is considered a freshwater species that exhibits marked salinity tolerance (McMillan and Moseley 1967, Kantrud 1991).

Seagrasses are not tolerant of prolonged exposure to air, although shoalgrass can be found in the intertidal zone (McNulty *et al*. 1972, den Hartog 1977). The seagrass species present in the Gulf have varying depth limits, with widgeongrass restricted to shallow water and the rest found to considerable depths depending on light penetration. Clover grass is tolerant of low light penetration, but the rest are restricted to depths that allow at least 11-25% surface irradiance (SI), with optimal conditions between 41-46% SI (Duarte 1991, Kenworthy and Haunert 1991, Dunton 1994, Fonseca 1994). In most Gulf of Mexico estuaries, turbidity restricts seagrasses to water depths of less than 3 m (Wolfe *et al*. 1988), although in very clear water areas of the Florida Keys seagrasses can be found in depths of up to 30 m.

Turtle grass is considered the climax species in seagrass succession (Zieman 1982). Shoalgrass, widgeon grass, clover grass and attached macroalgae (especially in Florida) are pioneer species that appear first, rapidly colonizing bare areas. These plants stabilize sediments and protect sediment surfaces from currents. Although sometimes absent, manatee grass appears next, usually intermixed with shoalgrass in the early stages and with turtle grass in later stages. Finally, when sediments are very stable, turtle grass colonizes the area. The early shoalgrass communities are usually simple mosaics. Structurally, the climax community is characterized by increased leaf area, and a concomitant increase in the abundance and diversity of epiphytic algae. These algae are very productive, sometimes contributing over 50% in overall primary productivity (Morgan and Kitting 1984). However, as both epiphytes and phytoplankton increase due to eutrophication, the resulting light reduction may cause seagrass loss (Heck *et al*. 2000)

Seagrasses provide trophic support to higher consumers through a grazing food web based on their epiphytic algae and epibenthic grazers like shrimp and gastropods (Kitting *et al*. 1984) and the secondary productivity of their epibenthic and benthic infaunal invertebrate communities. Fishes and squids live in or above the plant canopy (Zieman 1982). Fish in seagrass beds can be categorized as permanent or seasonal residents, temporal migrants, and transients (Kikuchi 1980, Zieman 1982). The permanent residents include relatively sessile species such as gobies whereas seasonal residents encompass those fish and invertebrates that use the meadows as nursery or spawning grounds. Drums, snappers, and grunts are common seasonal residents. Throughout the Gulf, red drum and penaeid shrimp use seagrass meadows as nursery and foraging habitat. In South Florida, gray and mutton snapper, and gag also make extensive use of seagrass meadows as nursery habitat (Thayer *et al*. 1978) and these species, along with other coral reef fish, may migrate from reefs into meadows at night to forage (Zieman 1982). Large offshore or oceanic fish such as mackerels and jacks are present in seagrass habitats from time to time.

The large *Halophila* meadows off the west coast of Florida are in close association with productive live bottom habitats, and may provide important foraging grounds for commercially and recreationally important fishes such as grunts, snappers, grouper, and flatfish (NMFS 2000a). However, the authors of the report are unaware of any data describing the contribution of the *Halophila* meadows to the west Florida shelf fishery resources.

3.2.1.1.2 Distribution in the Gulf of Mexico

There are about 1,927,500 ha of seagrasses in estuarine and nearshore areas of the Gulf of Mexico including Mexico and Cuba (Duke and Kruczynski 1992). An estimated 1 million ha of seagrasses are found in the estuaries and nearshore areas of the Gulf states (Iverson and Bittaker 1986; Orth and Montfrans 1990) with approximately 95% found in Texas and Florida (Duke and

Kruczynski 1992). Seagrasses are also abundant in tropical areas of the Gulf along the coast in Mexico, especially in the Laguna Madre de Tamaulipas (Withers 2002) and shallow nearshore areas of the Bay of Campeche.

In Texas, the majority of seagrasses (90%) are found on the lower coast (Pulich 1998). The combination of low rainfall, high evaporation and salinities above 20 ppt are the primary reasons for this concentration. About 72,249 ha (185,800 ac) of seagrasses are found in Laguna Madre (including Baffin Bay). Shoalgrass dominates in the upper Laguna Madre and manatee grass dominates in lower Laguna Madre. In upper Laguna Madre, seagrasses have declined slightly since 1990 and species composition is changing due to decades of salinity moderation (Quammen and Onuf 1993). In lower Laguna Madre coverage has also declined and species composition has changed dramatically from domination by shoalgrass in the 1970s to domination by manatee grass in the 1990s. Another 9,960 ha (24,600 ac) of primarily shoalgrass are found in the Corpus Christi Bay estuarine complex (including Nueces Bay and Redfish Bay; Pulich 1998). Coverage is fairly stable within this system. Only 9,200 ha (22,710 ac) of seagrasses are found in Galveston, Matagorda, San Antonio, and Aransas Bays. Nearly all the seagrasses in Galveston Bay are gone, due mostly to anthropogenic factors, but in the remaining upper coast bays, seagrass area fluctuates depending on freshwater inflow.

In Louisiana, seagrass coverage in 1998 was estimated at 5,657 ha (13,974 acres) (Handley no date). Seagrasses have been extirpated from, White, Calcasieu and Sabine Lakes, the Mississippi River Delta, and the quiet waters behind most of the barrier islands. Seagrasses still exist in Pontchartrain, with mostly *Ruppia* in dryer years, while *Vallisneria* (tape grass) occurs in wetter years. The only other area where seagrasses remain is Chandeleur Sound. All five species are found in the Sound. Seagrass coverage in this area was relatively stable between 1978-1989, probably because they are far from human impacts.

In Mississippi, there were 49,420 (122,119 ac) of seagrasses, primarily shoalgrass and manatee grass, reported in 1976 (Eleuterius and Miller (1976). However, seagrasses have declined dramatically in the state (Handley no date). Currently, the majority of the state's seagrasses are found in Gulf Islands National Seashore. In 1987, there were 140 ha (345 acres) of seagrasses in the shallow waters north of the barrier islands. Evidence of the declines can be seen on the north side of Horn Island where there were 169 ha (417 ac) in 1956, 56 ha (138 ac) in 1987, and only 6 ha (14 ac) in 1992, a decline of 96.5%.

In Alabama, there are no recent estimates of seagrass coverage. In 1982, there were 1496 ha (3696 ac) of seagrasses in the Mobile Bay (Stout *et al*. 1982). It seems likely, in light of the general decline of living resources reported for Mobile Bay (Duke and Kruczynski 1992) and those Gulfwide, that the seagrasses have sustained losses due to a variety of dredge and fill activities and other anthropogenic impacts.

Large expanses of seagrass are located in the estuaries and the shallow waters of the continental shelf on the Gulf coast of Florida. The majority of seagrasses are concentrated in the Big Bend area, Florida Bay (especially Everglades National Park) and the Florida Keys (Duke and Kruczynski 1992). Much of the historic seagrass coverage within Tampa Bay has been lost. Turtle grass, manatee grass and shoalgrass are found in the both bays and nearshore areas.

Widgeon grass is found mainly in brackish areas near the mouths of rivers (Iverson and Bittaker 1986). In the Big Bend area, where there are no embayments, seagrasses extend out onto the broad, shallow continental shelf (MMS 1985). In the shallow areas (> 9 m) near the mainland, turtle grass, manatee grass and shoal grass were found; seaward of that zone, but still in the same depths, the seagrass community consisted of turtle grass, manatee grass, shoalgrass and two species of clover grass, *Halophila decipiens* and *H. engelmanni*. In depths of 10-20 m, there was a mixed macroalgal/seagrass assemblage; the only seagrasses found were clover grass (both species).

3.2.1.1.3 Threats and consequences of alteration

Seagrass coverage has declined in almost all areas of the Gulf of Mexico since the 1950s. Estimates of losses range from about 25% in the lower Laguna Madre (Pulich 1998) to nearly 100% in parts of Louisiana, Mississippi, and Alabama (Handley nd). There are both natural and anthropogenic causes of seagrass destruction. Storms, floods and droughts, as well as natural turbidity, sedimentation and bioturbation can result in seagrass loss. For example, although Hurricane Andrew had no appreciable effects on the seagrasses of south Florida (Tilmant *et al*. 1994), the heavy wave action associated with Hurricane Camille destroyed approximately 58% of the seagrasses in Mississippi Sound (Eleuterius and Miller 1976). Both increases in salinity due to drought and decreases in salinity due to floods can kill seagrasses as can light reductions due to turbidity. In areas where sediment loads are extreme, seagrasses can be lost due to burial (Pulich 1998).

Despite the fact that there are numerous natural causes of seagrass loss, human activities are far more devastating. In Florida, seagrasses within estuaries (i.e., closer proximity to human activities) were far more stressed and degraded than those in the shallow nearshore (Zieman and Zieman 1989). Urban development and the resulting increases in runoff (watershed clearing, more hard surfaces) and nutrient inputs (wastewater and industrial effluents, nonpoint sources) cause greater turbidity and increased algal growth (phytoplankton and epiphytes). Both of these, in turn, cause reductions in the amount of light penetrating the water, reduce seagrass productivity by limiting photosynthesis, and eventually result in seagrass death.

Dredging and filling associated with both coastal development and marine navigation are also major threats and have already resulted in losses of thousands of hectares of seagrass habitat in the Gulf of Mexico. In addition to the physical destruction or burial of seagrasses, dredging may also cause light reductions in adjacent seagrass areas that may also result in seagrass loss (Onuf 1994, Dunton *et al*. 1998a).

Both small and large boats as well as commercial fishing vessels may also negatively affect seagrasses. The wakes of large vessels cause at least short-term turbidity, and in areas with heavy boat traffic, this effect could be similar to the turbidity caused by dredging. Small boats often physically disturb seagrasses in shallow water through propeller scarring which destroys both above and below ground tissues (Phillips 1960, Zieman 1976, Eleuterius 1987, Dunton *et al*. 1998b). Scarring of seagrasses usually results from: 1) proximity of seagrasses to densely populated areas including waterfront homes; 2) shortcuts taken at channel junctions, around shallow areas, and between islands as well as accidental straying from channels; 3) entry into shallow meadows from blind channels dredged for gas well or pipeline access; and 4) channels that are illegally marked and maintained through frequent and intensive boat traffic directly through meadows (Dunton *et al*. 1998b). Commercial fishing carried out using bottom trawls also causes sediment and nutrient resuspension and may contribute to light attenuation. Threats to seagrasses are discussed in greater detail in Section 3.5.3.1, Physical Alterations from Non-Fishing Activities.

Seagrass loss has numerous consequences. Due to their critical function as nursery areas, the loss of seagrasses has the potential to impact both the ecology and economy of an area (Zieman and Zieman 1989). Once seagrasses are completely lost, regrowth is difficult, and this results in the loss of all the organisms the meadows fed and sheltered (Duke and Kruczynski 1992). It has been estimated that 98% of commercial landings in the Gulf of Mexico involve estuarine-dependent species (Chambers 1992). Loss of seagrasses may also affect productivity in adjacent habitats due to reductions in organic carbon inputs from seagrass detritus.

3.2.1.2 Emergent, intertidal wetlands (marshes & mangroves)

Emergent, estuarine and/or nearshore, vegetated wetlands provide essential habitat for many of the Gulf's managed fish species. In the Gulf of Mexico, salt marshes dominated by smooth cordgrass (*Spartina alterniflora*) and/or needle rush (*Juncus roemarianus*), and also marsh hay cordgrass (*Spartina patens*) are found in the temperate north. In sub-tropical and tropical areas, mangrove communities of halophytic trees and shrubs such as red mangrove (*Rhizophora mangle*) or black mangrove (*Avicennia germinans*), are found. The vegetated wetlands found in estuaries are among the most productive ecosystems on earth (Teal and Teal 1969, Odum *et al*. 1982). Both marshes and mangroves have similar requirements: soft sediments (usually), regular inundation from tides, some freshwater, and low to moderate wave energy. They occupy the area where the sea meets the land and contain terrestrial and aquatic elements. They may alter the sediment on which they grow and function as "stable sediment builders" through peat formation and their effect on local sedimentation patterns (Odum *et al*. 1982, Mitsch and Gosselink 1993).

Marshes and mangroves are open ecosystems that are strongly coupled with surrounding ecosystems both physically and biotically (Gosselink 1984). They are integral parts of the estuarine system, serving as nursery areas for larval and juvenile invertebrates and fish and as a source of much of the organic material needed to sustain the detrital food webs that dominate energy flow in both estuarine and marine ecosystems. In addition, marshes and mangroves remove contaminants from water and recycle inorganic nutrients, playing major roles in the global cycling of nitrogen and sulfur. Physically, they reduce erosion and buffer inland areas from storm damage by absorbing wave energy and controlling floods.

3.2.1.2.1 Ecology

The structure and organization of plant and animal communities in emergent, estuarine vegetated wetlands is largely determined by the physical effects of wave action, tidal flooding, periodic emergence, and fluctuating salinities (Odum *et al*. 1982, Pennings and Bertness 2001, Ellison and Farnsworth 2001). Very heavy wave action or strong currents preclude formation of emergent vegetation in estuaries, thus these types of communities are generally found in areas of relatively quiet water. Flooding with seawater is both a subsidy and a stress for the plant communities that characterize estuarine wetlands (Odum 1980). As a stressor, flooding results in waterlogged, anoxic soils that may contain toxins such as sulfides (Odum *et al*. 1982, Ellison and Farnsworth 2001, Pennings and Bertness 2001). Fluctuating salinities in both soil and water are additional stresses resulting from flooding. The osmotic challenge of dealing with a range of salinities in water from fresh or nearly fresh to hypersaline excludes many plants and animals from the estuarine intertidal zone. In addition, there are few plants able to tolerate the salty soils that characterize the habitat. As a subsidy, tides bring in oxygen and nutrients and remove built up detritus, salts, wastes and toxins. Both salt marsh plants and mangroves have a number of adaptations (e.g., adventitious roots, well-developed aerenchyma and anaerobic metabolic pathways, mechanisms for salt exclusion or excretion) that allow them to tolerate the stresses caused by flooding and build up of salts. Both tidal flooding and salinity work to help exclude competitors from the habitat.

The predictability of tides is a factor in whether flooding is primarily a stress or subsidy. On the Gulf coast, tides range from only 20-40 cm and are driven mostly by atmospheric pressure and wind direction (Pennings and Bertness 2001). Thus, both the timing and duration of flooding and exposure are unpredictable resulting in generally more stressful conditions than those found in areas with daily tidal inundation and exposure, especially during summer and cold weather. Extended periods of flooding may cause salinity and water temperature to increase, a build up of toxins in plant rhizospheres, suffocation of plants due to lack of oxygen in waterlogged soil, inaccessibility of nutrients due to chemical interactions between water and sediment, and other conditions that may exceed plant or animal tolerance thresholds. Extended periods of emergence result in high soil salinities and temperatures, drying of substrate or body tissues, lack of water and nutrients, and build up of wastes, salts and/or toxins. At higher elevations, infrequent flooding may result in very high soil salinities. Freshwater inputs, from either rivers or rainfall, can help ameliorate some of the effects of extended flooding or exposure by reducing water and soil temperatures and salinities, keeping soils moist and bringing in both oxygen and nutrients.

In general, decomposition is rapid in Gulf coast marshes due to the hot climate and there is little accumulation of peat (Pennings and Bertness 2001). Mild winters usually allow year-round plant growth. High soil salinities result in increased abundance of salt-tolerant plants and increased importance of salinity in determining plant zonation. The interaction of tides and salinity produce plant communities that exhibit fairly uniform patterns of zonation throughout the Gulf. Salt marsh communities are dominated by smooth cordgrass in the intertidal zone, with marsh hay cordgrass (*Spartina patens*) or rushes (*Juncus* spp.) in the upper intertidal zone. As elevation above MSL increases and tidal inundation becomes less frequent, cordgrass density declines and various associations of other halophytic grasses (e.g., *Paspalum*) and succulents such as glasswort (*Salicornia* spp.) take its place. This assemblage is generally indicative of the bayshore supratidal margin (Britton and Morton 1989). Above this zone, salt cedar grass (*Monanthochloe littoralis*) or sea ox-eye daisy (*Borrichia frutescens*) marks the elevation above which tidal inundation rarely occurs. The width and density of the cordgrass zone is greatest from Galveston Bay, Texas through the Big Bend region of Florida, the portion of the Gulf where freshwater inflows are greatest.

Detritivores are more abundant in Gulf coast marshes than in areas where winters are colder and there is increased consumer pressure on organisms at lower trophic levels (Pennings and Bertness 2001). Benthic infauna, such as polychaetes, burrowing bivalves and fiddler crabs, are often abundant in the soft sediments of estuarine marshes. These burrowing and deposit feeding organisms help aerate sediments and regenerate nutrients for marsh plants and are important sources of food for higher consumers like birds and fish. The plants provide both food and habitat for a variety of organisms. Although the grasses themselves are generally not grazed, grazing gastropods find abundant epiphytic algae and lichens at their bases during low tides. Decaying plants provide abundant detritus to the benthic infauna and detrital food web. The plants also provide complex structure to protect juvenile invertebrates and fish. These organisms feed on phytoplankton and zooplankton in the water column as well as the benthic infauna and epiphytic algae.

The brown shrimp, a species managed by the Gulf council, is a notable example of a fishery species that is intimately linked to the salt marsh. Its life cycle is typical of estuarine dependent organisms (Gosselink 1984). Brown shrimp are spawned offshore during the spring and summer, and the eggs, larvae and postlarvae ride the currents of the Gulf through late summer and fall until they are carried into the estuaries from February through April. Once in the estuaries, they move deep into the marsh where they spend their early juvenile stages in protected marsh ponds and bayous. As their size increases, they move out of the shallow areas of the marsh and into progressively deeper water. The deeper waters are used as staging areas from which they emigrate back into the Gulf during late spring and summer. Emigrations occur at night and during the lunar tidal cycle when tides are highest. Other penaeid shrimp, as well as red drum, also migrate between estuarine habitats, including estuarine wetlands, and offshore. Gray snapper are found in marshes in the northeastern Gulf of Mexico (Stout 1984). Many fish and invertebrate (especially decapod) forage species are found in marsh habitats as juveniles or adults or both.

Typical mangrove zonation in Florida is red mangrove between mean low water and mean high water, grading to black mangrove in the upper intertidal and supratidal margin (mostly above MHW), with white mangrove (*Laguncularia racemosa*) and buttonwood (*Conocarpus erectus*) in areas where tidal inundation rarely occurs. Buttonwood generally marks the transition to upland areas (Odum *et al*. 1982, Ellison and Farnsworth 2001). There are very few understory plants in mangrove communities but epiphytic plants are fairly common (Ellison and Farnsworth 2001). The influence of physical and chemical factors on mangrove zonation appears to be more indirect through its effect on interspecific competition (Odum *et al*. 1982). Distribution of the different species appears to be affected largely by the effects of salinity on their competitive ability.

Many animals use mangrove habitats in Florida, (Mitsch and Gosselink 1993) including at least 220 species of fish (Odum *et al*. 1982). Mangroves function as a source of food and shelter for a wide array of organisms. In particular, the prop roots of red mangroves provide a source of hard substrate in an otherwise soft sediment system and can be heavily populated with a diverse assemblage of both sessile and motile invertebrates as well as algae. The invertebrate fauna is composed primarily of filter or suspension feeders and detritivores. Two distinct assemblages are found depending on whether roots are continuously submerged or intertidal (Ellison and Farnsworth 2001). In areas where roots are constantly submerged, a community composed primarily of sponges and ascidians dominates. In areas where roots are subjected to tidal fluctuations, communities develop that are dominated by barnacles and oysters with varying amounts of algae. Wood-boring isopods may also be abundant as well as polychaetes and amphipods. Amphipods are especially abundant on roots with luxuriant growth of algae (Tunnell 2001). Other invertebrates found on roots as well as in the canopy include numerous species of crabs and gastropods.

Red mangroves function as fish habitat by providing shelter within the complex prop root system, and by providing abundant detritus to fuel the detrital food web on which fishes and invertebrates depend (Odum *et al*. 1982). Goliath grouper, red grouper, Nassau grouper, gag, bluefish, cobia, mutton snapper, gray snapper, dog snapper, lane snapper, red drum, Spanish mackerel, king mackerel, and gray triggerfish all use mangroves as juveniles, subadults or adults, primarily as foraging habitat. Gray snapper is the most abundant snapper in mangrove habitats and juvenile Goliath grouper are the most abundant of the groupers.

The pneumatophores of black mangroves do not have a well-developed invertebrate fauna. In the south Texas where it is the only mangrove species, the fauna consists of a few species of molluscs that are derived from other similar habitats such as salt marshes (Britton and Morton 1989) and fiddler crabs. During periods of high tide, this habitat also provides a refuge for fish and shrimp similar to that provided by salt marshes.

3.2.1.2.2 Distribution in the Gulf of Mexico

More than half of the wetlands in the United States were found in the Gulf of Mexico region including 58% of saltmarshes (NOAA 1991) and all mangroves. Of the total wetland area in the Gulf of Mexico region, 66% was saltmarsh and 16% was mangrove.

Salt marshes are found primarily within coastal bays and deltaic areas throughout the Gulf of Mexico. In Florida, they are also found fringing the Gulf in the Big Bend Region. Despite low tidal amplitude, these wetlands can be very extensive due to the very low slopes that characterize the coastline throughout much of the region (Table 3.2.1). Salt marshes dominate in the northern Gulf, from the Texas Coastal Bend to Cedar Key, Florida (Figures. 3.2.3 to 3.2.7), reaching their greatest development in Louisiana on the Mississippi River Delta Plain (see Section 3.2.1.2 for a more detailed overview of this area). In central and southern Texas, marshes are limited to thin fringes of succulent halophytes such saltwort (*Batis maritima*), glasswort (*Salicornia* spp.) and sea-oxeye daisy (*Borrichia frutescens*). In the Laguna Madre in Texas and Tamaulipas, Mexico marshes are essentially absent and are replaced by unvegetated wind-tidal flats due to a lack of freshwater inflow, hypersalinity, and high summer temperatures.

Mangrove, particularly red mangrove, distribution is limited by freezing temperatures. After more than 10 years without a hard freeze, black mangrove has become widespread on bayshores from Corpus Christi, Texas to the Rio Grande. Black mangroves may also be found in scattered patches throughout much of the northern Gulf coast (Odum *et al*. 1982). Red mangrove has been reported as far north as Cedar Key, Florida (29°10' N). South of this area mangrove vegetation mixes with marsh vegetation until it dominates on the southern coast (Odum *et al*. 1982) (Figures. 3.2.3 to 3.2.7). In tropical areas throughout the rest of the Gulf (including Mexico), red mangroves dominate in the estuarine intertidal zone and may be found along Gulf shorelines, particularly in Florida and the western Yucatan Peninsula (Bay of Campeche).

3.2.1.2.3 Consequences of alteration

The largest losses of salt marshes in the United States between the 1970s and 1980s were in Texas (≈3300 ha) and Louisiana (≈20,000 ha) (Frayer 1991). In Louisiana, most of the loss was conversion of salt marsh to unvegetated bay bottom due, in part, to subsidence. Peak salt marsh loss occurred in the 1970s, but the rate of loss has diminished since the mid 1980s, when it was estimated that from 1-1.5% or about 8000 ha of Louisiana salt marshes were converted to open water each year (Gosselink 1984, Dunbar *et al*. 1990, Turner 1990). The most recent estimates of salt marsh loss range between 6475 and 9065 ha of marsh lost each year (Coast 2050 report 1998). Between the 1930s and 1983, there was a net loss of approximately 212,000 ha of land in the Mississippi River delta (May and Britsch 1987); much of that loss was probably salt marsh.

Construction of dams and dredging of navigational canals are two of the major anthropogenic factors that cause marsh loss through alterations of sedimentation patterns and/or outright destruction (Duke and Kruczynski 1992). Other major impacts include construction activities associated with oil and gas production, especially pipelines; levee construction; and dredge and fill activities associated with coastal development (Coast 2050, 1998). In addition, as coastal development proceeds, the increased nutrients associated with septic systems, wastewater treatment plants, and urban runoff contributes to a decline in water quality and ultimately declines in wetland habitat.

Miscellaneous factors that impact coastal wetlands include marsh burning, marsh buggy traffic, onshore oil and gas activities, and well-site construction (MMS 1996; 2002a). Bahr and Wascom (1984) report major marsh burns have resulted in permanent wetland loss. However, properly timed and managed marsh burns have the potential to enhance accretion rates (i.e., marsh build up) and decrease probabilities of catastrophic marsh fires. Marsh burns also increase plant diversity and production, and are necessary to prevent succession into non-grassland vegetative stages (Barry Wilson, Gulf Coast Joint Venture, personal communication). Sikora *et al*. (1983) reported that in one 16 km^2 wetland area in coastal Louisiana, 18.5 % of the area was covered with marsh-buggy tracks. Marsh buggy tracks have been found to open new channels of water flow through an unbroken marsh, thereby inducing and accelerating erosion and sediment transport. Marsh buggy tracks are known to persist for anywhere up to 10 to 15 years in Louisiana marshes. Well-site construction activities include board roads and ring levees. Ring levees are approximately 1.6 ha impoundments constructed around a well site (MMS, 1996). Coastal land loss is typically a result of complex interactions among natural and human activities upon the landscape. Therefore it is difficult to isolate an activity as the singular cause of a specific of coastal land loss. However, general assumptions can be made for most areas regarding the primary physical process that removed or submerged the land, as well as the primary actions that initiated the process. The following table is a breakdown for Louisiana of the total hectares lost due to these specific anthropogenic causes (USGS, no date).

Human activity areas in Louisiana	**Hectares lost**
oil and gas channels	31,153
navigation channels	4,548
borrow pits	4,504
access channels	531
burned areas	295
sewage ponds	125
agriculture ponds	72
drainage channels	44

(USGS, no date)

In oil and gas fields, access canal spoil banks impound large areas of wetlands. With 41,000 onshore coastal wells drilled in Louisiana as of 1984, the total acreage of impounded, dredged, and filled wetlands is substantial and would amount to 32,800 ha if there were two wells per ring levee in 1984 (MMS, 1996).

Mangroves are degraded by a variety of human activities including impounding or ditching for mosquito control, reductions in freshwater inflows, clearing and dredge and fill activities associated with navigation and coastal development (Duke and Kruczynski 1992). Mangroves actively concentrate heavy metals, and these metals may be transmitted into the detrital food web through mangrove litter.

Coastal wetland loss has direct, negative impacts on fisheries. Although the exact mechanisms through which coastal wetlands and fisheries productivity are coupled is not always clear, there is a strong correlation between the two (Turner 1992). It has been estimated that an annual 1% decline in wetland area is equivalent to a 1% decline in fishing yield. Thus, for the period of 1982-2002, cumulative wetland losses have resulted in a minimum of $380 million (1982 dollars) in loss of dockside value. However, losses are probably as much as three times more when the value added through processing and delivery is taken into account (Jones *et al*. 1974). Wetlands losses may also significantly impact the availability of approved shellfish waters (Duke and Kruczynski 1992). Coastal wetlands also have value as protection against hurricane winds and flooding (Farber 1987).

3.2.1.2.4 Mississippi River Delta

The area between Sabine Lake, Texas and Mississippi Sound, including the Mississippi River Delta has been called the “Fertile Fisheries Crescent” due to the apparent relationship between marsh vegetation and fishery productivity in the area (Gunter 1967). The Mississippi Delta Plain region is one of the best-developed river deltas in the world (Gosselink 1984). It supports the largest fishery in the nation; it produces more furs than any other area in the U.S. and is an important wintering area for migratory waterfowl. It is an area of dense urban population (New

Orleans metropolitan area) and intense industrial activities. The ports handle more tonnage than any others in the U.S., and there is a large amount of mineral extraction (primarily oil and gas) in the delta. The very high habitat value of the delta for fish and other animals is the result of the interaction of the mild, subtropical climate, the adjacent nearshore and Gulf, and the rivers, which together have shaped both the geomorphology and biology of the area.

Over the past 10,000 years the Mississippi River and its associated distributory rivers and basins (e.g., Atchafalaya River) built the present southeastern coast of Louisiana with a series of overlapping delta lobes (Gosselink 1984, Reed 1995). The geologic cycle is one of delta lobe growth (progradation) with concomitant marsh expansion, river abandonment, and destruction. When the river begins to abandon its major deposition site, the transition from one delta lobe to another occurs, and marine reworking processes and subsidence take over in the abandoned lobe. The marsh of the abandoned lobe gradually becomes completely submerged, eventually resulting in loss of marsh vegetation. Once the vegetation is gone, marsh soils break up and the emergent delta lobe is replaced by open water. These processes usually result in a delta edge characterized by a series of barrier reefs or islands that protect the inner estuary. The life span of a typical delta lobe is about 5,000 years. Numerous delta lobes can be found beneath continental shelf deposits, illustrating the importance of submergence in controlling total marsh area (Gosselink 1984).

With nearly 293,407 ha of emergent wetlands, the Mississippi River Delta (MRD) is the largest continuous wetland system in the U.S. (Gosselink 1984) Estuarine marshes comprise about 71% of total wetland area. Marsh vegetation type is largely determined by freshwater inflow. As a delta lobe begins to form, the river is the primary influence, and marsh vegetation is composed of freshwater species. The freshwater marshes expand as the lobe grows, but areas that become cut off from the major flow of the river become more influenced by estuarine and marine waters, resulting in formation of estuarine marshes. When the river abandons the lobe and the delta begins to be reworked, marshes become increasingly saline. At this point, continued marsh development, particularly away from the coastline, is controlled more by biotic factors such as peat formation, rather than sediment deposition. Thus, there tends to be a concentration of freshwater marshes around the river in the developing delta lobe, despite the fact that it is adjacent to the Gulf, backed by bands of estuarine marsh that extend inland to the extent of tidal influence, where freshwater marshes are found again. The composition of marsh plant communities is the same as that described for Gulf marshes in general.

Like other marshes, those of the Mississippi River Delta provide shelter and trophic support to fish. The fish fauna of the MRD is diverse and contains permanent residents and transients, mostly juveniles) that use the marshes as nursery habitat (Gosselink 1984). The majority of these fish feed on the benthic and epibenthic invertebrates that are abundant throughout the marshes. Most biological activity is confined to the marsh edge, and this is probably the reason that the best predictor for inshore shrimp catch is marsh edge length. Biological productivity tends to peak as delta lobes are destroyed, possibly due to the increase in edge that occurs as different areas of the marsh are submerged and plants die.

Marshes in the Mississippi River Delta have been lost to open water fairly rapidly over the last 20-30 years (Gosselink 1984). To remain in the intertidal zone, marshes must accrete vertically as fast as they sink, and this is not happening in most areas of the delta. One important reason is that the Mississippi River does not supply as much sediment as it once did. Sediment supplies have been reported to be greatly reduced from historical levels (Keown *et al*. 1981). The average annual suspended load presently reaching the Gulf is approximately 60 x 10^6 m^3/yr. (Reed 1995). This reduction is partly due to damming, which stops sediments from moving down river as well as removing the coarser sediments (Gosselink 1984). Artificial levees line the entire length of the river, preventing sediment and water from being dispersed into the adjacent flood plain and wetlands by stopping overbank flow and crevasse splays development. Most sediment is funneled to the mouth of the river and discharged off the edge of the continental shelf. In addition, drainage canals along the marsh-upland interface have interrupted rain runoff and sediment flow into the delta by conducting water directly into estuarine lakes.

Another important cause of marsh loss in the Mississippi River Delta is "coastal submergence" (Gosselink 1984). This is a combination of sea-level rise and subsidence. The processes controlling subsidence in the Mississippi River delta plain are complex and vary in time and space. Consolidation, settlement, geochemical processes, and faulting all affect and contribute to subsidence (Reed 1995). Based on modeling studies, fluid withdrawal from oil/gas reservoirs appears to have a localized influence on subsidence, amounting to a lifetime subsidence of as much as 80 cm directly above reservoirs (Turner and Calhoon 1987). An estimated 50,992 ha of oil and gas fields have a subsidence potential greater than 10 cm.

The main source of suspended sediment to interior parts of Barataria-Terrebonne estuary (BTE), at the mouth of the Mississippi River, is reworking of sediments from the nearshore and coastal bays (Reed 1995). Land loss rates from all causes for the entire BTE averaged from 4,662 ha/year (18 mi^2/year) (1956-1978) to 5,698 ha/year (22 mi^2/year) (1978 to 1990). These losses of land mean that the delta will be smaller than it was historically and will not be able to support the same amount of marsh as it once did. About 118,981 ha of marsh (all types) were lost to open water from 1956 to 1978. Additional losses occurred due to development and conversion to agriculture. Between 1990 and 2000 land loss rates averaged 6,216 ha (24 mi^2/year).

In the spring of 2000, fishermen and scientists noticed that certain areas of coastal marsh in south Louisiana were turning brown (Louisiana Coastal Restoration 2001). Although patchy areas of dieback had been noticed in the past, the size of the current dieback area was unprecedented. The areas most affected were the salt marshes between the Mississippi and Atchafalaya rivers.

Since early summer of 2000, the area of the marsh dieback had increased, but has since decreased. Approximately 50% of affected areas are recovering, however, some are permanently dead. Inspections of roots and rhizomes indicate that this event is not simply a dieback of aboveground plant material but often of the entire plant. Although scientists believe the dieback may have been related to prolonged drought conditions that had existed in the area for the past few years, it is likely that as yet undetermined physical or biological stresses were also contributing factors.

3.2.1.2.5 Louisiana wetland restoration efforts

Current and pending projects to divert river water back into marshes, are designed to halt the loss of marshland and lower salinities, bringing them closer to historic levels. This will have the effect of shifting the location of some present marine habitats to more seaward positions, and restoring brackish habitats to their historic locations. Details about these large-scale restorations efforts can be found in the Coast 2050 report (1998).

Two major structures have been completed at this point, the Caernarvon Diversion Structure (15 miles below New Orleans) and the Davis Pond Diversion Structure (23 miles above New Orleans). The Caernarvon structure has been in operation since 1991, while the Davis structure began operating in July 2002. There are also a number of smaller "siphon" facilities operating along the Mississippi River. Other large projects, such as those for Bayou Lafourche and Fort Jefferson are proposed but not yet under construction (Dr.Bill Good, personal communication). The largest water diversion structure in the system, the Old River Control Structure, which controls the flows between the Mississippi and Atchafalaya Rivers, may also be used as part of this diversion network in the future, although that was not its originally intended purpose (Dr.Len Bahr, personal communication).

The Caernarvon Diversion Structure shunts Mississippi River water and associated sediments and nutrients to the marshes and coastal bays of Breton Sound. Some effects from the 11-year operation of the Caernarvon structure have been documented. It is estimated that the project has preserved 6,475 ha of marsh and benefited 31,160 ha of the estuary. Before the structure began operating, the Breton Sound area was losing approximately 405 ha of wetland annually. During 1992-1994 a sample zone of 926 ha showed an increase of 5.9% (164 ha) of wetland a year. In addition, sizeable beds of submerged aquatic vegetation have developed in the Sound's landward zone. There has been an over 50% reduction in saline marsh vegetation, a nearly 50% increase in brackish marsh vegetation, a 7-fold increase in freshwater marsh vegetation, and an overall increase in marsh plant diversity. Monitoring of fisheries and wildlife species indicates that most have exhibited little obvious change or slight increases (e.g. blue crab, white shrimp, red drum, spotted seatrout, and waterfowl). There have been substantial increases recorded for largemouth bass, menhaden, alligator, and muskrat; but brown shrimp abundance has decreased. Oyster production has tripled, but the location of the most productive beds has shifted seaward.

Grand Lake is the principal salinity transition zone where salinities may change by 5-8 ppt, with waters north of the lake being mostly fresh, and waters south of the lake being mesohaline (Dr. Robert Twilley, personal communication). Water quality in the Sound has not shown signs of any significant decline, and it appears that water-borne nutrients (e.g. nitrogen) are being absorbed by the marsh before reaching open Gulf waters. This may help decrease the size of seasonal anoxic zones in the northern Gulf in the future. The increase in oyster abundance and their filtering capacity may also be helping to maintain the Sound's water quality.

Efforts are being made to time water releases to make them more compatible to the estuary's ecological cycles. Water is presently being delivered to the system using various types of pulsed releases, which seems to be the most effective way to maintain the system. While this approach appears to work well for the system's plant biota, it is uncertain how fisheries are being affected by this technique (Dr. Robert Twilley, personal communication).

The Davis Pond Diversion Structure will transfer river water from the Mississippi to Lake Cataouache, which feeds into Lake Salvador, and eventually into the marshes in the lower reaches of the Barataria Bay estuary. Controlled releases will be designed to mimic the spring floods which occurred in the past. Operation of the structure is expected to preserve 13,355 ha of marshland and benefit 314,452 ha of the estuary. Baseline biological monitoring began in 1998, will continue as the structure becomes operational, and will include a 4-year intensive study of biological effects, followed by 46 years of long-term monitoring. Fishery-dependent data will also be assessed and hydrological and vegetational changes will be documented. Management of the salinity regimes will focus on the locations of the 5 and 15 ppt isohaline lines in the estuary.

While river water diversion activities like those described above, have the effect of shifting marine-oriented habitats seaward, increasing estuarine habitat overall, conserving marshland, restoring lower salinity habitats to their historic locations, and maximizing the potential of these areas for fish and shellfish production in the long-term.

3.2.1.3 Soft bottom (mud, sand, or clay)

Sediment type (discussed in Section 3.1.1.2) is a major factor in determining the associated fish community (Hildebrand 1954; Hildebrand 1955; Chittenden and McEachran 1976; Darnell *et al*. 1983). Shrimp distribution closely matches sediment distribution. White shrimp (*Litopenaeus setiferus*, formerly *Penaeus setiferus*) and brown shrimp (*Farfantepenaeus aztecus*, formerly *P. aztecus*), occupy the terrigenous muds, while pink shrimp (*Farfantepenaeus duorarum*, formerly *P. duorarum*) occur on calcareous sediments (Pattillo *et al*. 1997). Shrimp have been shown to actively select substrate type (Williams 1958). Similar sediment-associated distributions have also been observed for many demersal fishes (Caldwell 1955; Hildebrand 1955; Dawson 1964; Topp and Hoff 1972).

The carbonate sediments present east of DeSoto Canyon and southward along the west Florida shelf support a distinct fish community (Chittenden and McEachran 1976). The pink shrimp predominates on calcareous sediments (Hildebrand 1955; Darcy and Gutherz 1984; Pattillo *et al*. 1997). The dominant fish species of the pink shrimp grounds include Atlantic bumper, *Chloroscombrus chrysurus*, silver jenny, *Eucinostomus gula*, sand perch, *Diplectrum formosum*, leopard searobin, *Prionotus scitulus*, fringed flounder, *Etropus crossotus*, pigfish, *Orthopristis chrysoptera*, and dusky flounder, *Syacium papillosum* (Hildebrand 1955). The bathymetric distribution of pink shrimp in the Gulf of Mexico extends to about 45 m (Hildebrand 1955; Pattillo *et al*. 1997).

The terrigenous sediments are divided into two communities. The brown shrimp grounds and the white shrimp grounds support distinct ichthyofauna (Chittenden and McEachran 1976). The two communities are separated by different bathymetric ranges (3.5-22 m and 22-91 m) based on the shrimp distributions of Hildebrand (1954). The white shrimp ground (3.5-22 m) fishes have a strong affinity for estuaries, while the fishes of the brown shrimp ground (22-91 m) are independent of estuaries. Chittenden and McEachran (1976) found Atlantic croaker, *Micropogonias undulatus*, to be the dominant species of the white shrimp grounds. The most dominant family was the drums (Sciaenidae) along with representatives from the snake mackerels (Trichiuridae), threadfins (Polynemidae), sea catfishes (Ariidae), herrings (Clupeidae), jacks (Carangidae), butterfishes (Stromateidae), bluefishes (Pomatomidae), and lefteye flounders (Bothidae). The dominant family of the brown shrimp grounds is the porgies (Sparidae), and the longspine porgy, *Stenotomus caprinus*, is the dominant species. Important supporting fauna includes a variety of species from the drums (Sciaenidae), searobins (Triglidae), sea basses (Serranidae), lefteye flounders (Bothidae), lizardfishes (Synodontidae), snappers (Lutjanidae), jacks (Carangidae), butterfishes (Stromateidae), cusk-eels (Ophidiidae), toadfishes (Batrachoididae), batfishes (Ogcocephalidae), scorpionfishes (Scorpaenidae), goatfishes (Mullidae), and puffers (Tetraodontidae) (Hildebrand 1954; Chittenden and McEachran 1976).

Sand/shell and soft bottoms are inhabited by various infauna (e.g. worms and crustaceans) and epifauna (e.g. sea pens) which act as ecosystem engineers and modify these habitats by the presence of their physical structure or burrowing in the substrate. In addition, some fishes like tilefish and red grouper constructs burrows or excavate depressions in sediments, increasing the habitat's original complexity (Coleman and Williams 2002). As such, ecosystem engineers can be considered an integral part of the habitats they occur in. Activities which directly or indirectly kill or remove ecosystem engineer species may substantially alter the nature of these habitats.

3.2.1.4 Live hard bottoms

Subtidal hard bottom communities, usually submerged rocky outcroppings or coral reefs, occur in coastal nearshore and estuarine regions of the Gulf of Mexico, primarily in Florida (the exception is 7 ½ Fathom Reef off the southern Texas coast – see Section 3.1.1.5). They range from Hernando Beach on the west central Florida coast to the Florida Keys. Coral reefs dominate hard bottom in the Keys whereas limestone outcroppings are prevalent in the west central region. The coral reef communities of the Florida Keys are discussed in Section 3.1.1.3 and 3.2.2.1.

Native limestone outcroppings are found along the shorelines and in the bays of the west central Florida coast. Additional areas may occur where dredging has exposed limestone bedrock (TBNEP 1994). Sessile epibenthic organisms that attach to the substrate dominate the biota, which consists of algae, sponges, hard and soft corals, hydroids, anemones, and bryozoans, along with motile invertebrates such as decapod crustaceans and gastropods. Species reported from hard bottoms in Tampa Bay include starlet coral (*Siderastrea radians*), loggerhead sponge (*Spheciospongia vesperia*), boring sponge (*Cliona celata*), sea whip (*Leptogorgia virgulata*) and the alga *Sargassum filipendulum* (Dawson 1953, Derrenbacker and Lewis 1985, Savercool and Lewis 1994). Like the oyster reefs with which they may occur, hard bottoms increase habitat complexity and provide structure, protection and trophic support to juveniles and adults of many marine fish species.

Sufficient light must reach the bottom for communities associated with nearshore and estuarine hard bottoms to thrive (Continental Shelf Associates, Inc. 1990). The symbiotic algae (zooxanthellae) contained in some coral and sponge species supplies its coral host with nutrients. The algae can only flourish in areas where sufficient light is transmitted through the water. Some nearshore coral species (e.g., *Solenestrea hyades*) are capable of expelling their symbiotic algae during times of stress, then later reacquire or regenerate them (Continental Shelf Associates, Inc. 1990). The epibiotic community on nearshore hard bottom areas can probably withstand periodic short-term turbidity and sedimentation, but prolonged episodes of turbidity due to dredging or other causes would likely result in damage or death of the community. It is difficult to predict the effects of loss of this habitat, but it would certainly result in lower productivity in both estuarine and nearshore zones and potentially declines in productivity of offshore fisheries.

3.2.1.5 Manmade structures

Intertidal hard shore communities occur throughout the Gulf of Mexico. In the northern gulf, this habitat consists of manmade structures like jetties, pilings, groins and breakwaters. Jetties and other manmade structures provide habitat for intertidal hard shore species and associated fishes that was essentially absent, especially west of the Mississippi River (Britton and Morton 1989). Dredging of tidal inlets, river mouths and ship channels, followed by construction of two parallel boulder jetties to stabilize and protect the channels from sedimentation began about 100 years ago. Other smaller structures, designed to stabilize shorelines and prevent erosion along bayshores and barrier islands are constructed of concrete and/or various types of natural and manmade rubble. In Texas alone, there are eight large inlets or ship channels protected by jetties and many smaller boulder jetties and concrete and/or rubble breakwaters along bay and barrier island shorelines.

The typical Texas jetty is constructed of granite and/or sandstone or limestone, is more or less triangular in cross-section (≈50 m wide at the base and 4 m wide at the crest) and may extend 2 km into the Gulf (Britton and Morton 1989). A core of blocks weighing up to 3 tons is placed on top of a base composed of small granite rocks (15-200 pounds), then the entire structure is covered with huge blocks weighing as much as 6 tons. The blocks on the crest fit loosely together and the spaces between them provide areas of quiet water and refuge for a variety of intertidal organisms.

The flora and fauna of jetties is a combination of epibenthic organisms from nearby offshore areas and oyster reefs, and tropical species that prefer artificial substrates (Britton and Morton 1989). The transitional character of the area coupled with low tidal ranges and the short time the community has had to develop has resulted in one of the simplest rocky shore communities anywhere in the world. In the northern Gulf, tropical influences decrease and with it, faunal diversity. South of the Texas Coastal Bend and Florida Big Bend, faunas are more diverse and increasingly tropical.

The two shores comprising each jetty are only a few meters apart, with the inner facing the restricted tidal inlet and protected from offshore waves and the other facing the waves of the open Gulf. However, both shores exhibit biotic zonation that is essentially tripartite (Stephenson and Stephenson 1949). At and above extreme high water is a supralittoral zone characterized by sea roach (*Ligia exotica*), and a supralittoral fringe characterized by lined periwinkle (*Nodolittorina lineolata*); between extreme high water and extreme low water is a mid-littoral zone characterized by fragile barnacle (*Chthamalus fragilis*) and false limpet (*Siphonaria* *pectinata*) and a sublittoral fringe characterized by various green, brown and red algae and associated small crustaceans like amphipods; and below extreme low water is a sublittoral zone characterized by the red sea urchin (*Arbacia punctulata*). One of the most prominent predators of the midlittoral zone is the stone crab, a species managed by the Gulf Council.

Many fish, including gray snapper, various jacks, Spanish mackerel, and occasionally king mackerel, frequent the waters around jetties, but most large species with commercial or sport value are transients (Britton and Morton 1989). Large schools of red drum migrate out of estuaries through the inlets and into the Gulf in spring and fall; passes are also used by penaeid shrimp migrating offshore to spawn. Huge schools of forage fish can be found around jetties, especially during late summer and fall. Although it has not been quantified, it seems likely that the additional and previously unavailable habitat provided by these structures increases productivity in the nearshore zone and may facilitate migration of estuarine dependent species, potentially contributing to the productivity of offshore fisheries. However, their role in altering and preventing longshore sediment transport might ultimately prove more costly than any contribution they make to coastal productivity.

3.2.1.6 Oyster reefs

The eastern oyster (*Crassostrea virginica*), itself an important commercial species, is found throughout the Gulf of Mexico in intertidal and subtidal areas where salinities are relatively high and winter air temperatures are moderate (Britton and Morton 1989, Day *et al*. 1989). Optimal temperatures and salinities for oysters range from 10 to 26 ºC and 12 to 25 ppt (SAFMC 1998). Other factors that influence presence and abundance of oysters include substrate type, sedimentation, water circulation, competition, predation, disease and pollution (Britton and Morton 1989). Estuarine areas containing suitable substrate that are relatively calm but have continuous water flow and low sedimentation are ideal habitats for oysters. Communities of eastern oysters and their tropical counterpart, *C. rhizophorae* are found in all areas of the Gulf of Mexico. The southernmost oysters in the U.S. are found in Oyster Bay, near Cape Sable, Florida Bay; north of that point, oysters grow almost everywhere in the Gulf of Mexico (McNulty *et al*. 1972). Communities dominated by oysters are variously termed oyster reef, oyster bar, oyster bed, oyster rock, oyster ground, and oyster planting (Bahr and Lanier 1981). This review focuses on naturally occurring aggregations of live oysters and oyster shell with associated flora and fauna that will be collectively termed “oyster reef”. Oyster reefs in the northern Gulf of Mexico are most extensive in Louisiana and Florida.

3.2.1.6.1 Ecology

Oysters are considered epibenthos or fouling organisms (Day *et al*. 1989) and require at least some hard substratum (“cultch”) upon which to settle (Britton and Morton 1989). As the oyster grows, its shell provides additional substrate upon which other oysters can settle. Optimal conditions for oyster spat survival are oyster shell, other shell or another firm surface on which to settle coupled with good water circulation to provide food and oxygen and remove waste and sediments. Eventually, oysters may build a reef that ranges in shape and size from small mounds or patches to broad, long ridges that extend several miles. Extensive oyster reefs often divide bays and change circulation patterns (Diener 1975), drastically altering the local estuarine environment and its associated flora and fauna (Britton and Morton 1989). Oysters may also be found growing singly or in clumps on nearly any manmade or natural structure including pilings, sea walls, jetties, old tires, bottles and cans, rocks, and red mangrove roots.

Oyster reefs are generally composed of an upper zone that consists of live oysters and associated sessile and motile fauna, over a core of buried shell and mud (Bahr and Lanier 1981). Mature oyster reefs usually extend into the intertidal zone (Britton and Morton 1989) but the maximum elevation of the reef depends on the minimum inundation time (Bahr and Lanier 1981). Although environmental factors such as seasonal temperature extremes and local tidal range may modify the degree to which oysters are able to tolerate life in the intertidal zone (Britton and Morton 1989), reefs are usually found only into the mid-intertidal because predation and siltation limit oyster populations in the lower intertidal and subtidal zones and exposure limits them in the upper intertidal (Bahr and Lanier 1981). In protected salt marsh estuaries, such as those occuring in much of the northern Gulf of Mexico, oyster reefs are usually relatively small and found in tidally-exposed areas adjacent to emergent vegetation with the majority of living oysters found in the intertidal area. Densities of living oysters in these reefs are usually very high. Reefs found in large, less protected bays are typically much larger (up to 5 miles long in some bays in Texas) with a central "hogback" of dead oysters in the intertidal portion flanked by a living reef community in the adjacent subtidal zone (Price 1954).

Because they are sessile filter-feeders, adult oysters require low sedimentation and adequate water movement to supply them with food and remove wastes. Although oysters can tolerate thin layers of sediment or partial burial, complete burial by gradual, natural sediment accumulation or catastrophic events (e.g., flood, dredge material disposal) will kill them (Britton and Morton 1989). In addition, both oyster feces and pseudofeces are significant sources of sediment on reefs and oysters that settle in areas with little water movement can smother themselves fairly rapidly (Lund 1957). High-density oyster communities are found in areas where water flow is high enough to supply food to many individuals but too low to cause turbidity by stirring up the bottom (Britton and Morton 1989).

As islands of hard substrate in areas where soft sediments predominate, oyster reefs help prevent erosion of intertidal wetlands, baffle water currents, regenerate nutrients and provide food and shelter for a variety of organisms (Day *et al*. 1989). Oyster reefs provide structural complexity in soft sediment environments that lack complexity by increasing available surface area for use by other organisms. An estimated 50 m^2 of surface area is available in every square meter of overall reef area (Bahr 1974). As many as 303 species have been documented on intertidal and subtidal oyster reefs (Wells 1961). Sessile and tubiculous invertebrates such as mussels, limpets, chitons, barnacles (*Balanus* spp.), anemones, bryozoans, hydroids, sponges, amphipods (e.g., Corophiidae) and polychaetes (e.g., Serpulidae, Spionidae) as well as motile arthropods such as crabs (especially family Xanthidae), snapping shrimp (*Alpheus* spp.), isopods and amphipods, polychaetes (e.g., Nereidae, Syllidae) and gastropods such as the oyster drill (*Stramonita haemastoma*) may be found in oyster reef habitat.

Oyster reefs serve as fish habitat by providing structure, protection and trophic support to juveniles and adults (SAFMC 1998). The voids between and among the oysters and other sessile organisms provide hiding places for fish larvae and juveniles. The eggs, embryos, and larvae as well as the juveniles and adults of the epibenthic organisms provide food for a variety of motile invertebrates, particularly the stone crab, and forage fish that in turn provide food to predatory fish at higher trophic levels. Three categories of finfish are found in oyster reefs: 1) reef residents; 2) facultative residents; and 3) transients. Several offshore reef fish species including gag, mahogany snapper, and gray snapper are transients in oyster reefs during some portions of their life cycle. Pinfish and pigfish, species of finfish preyed upon by reef fish, also inhabit oyster reefs as transients. In the northern Gulf of Mexico (north of Galveston Bay, Texas to northwestern Florida) where seagrasses are not abundant, oyster reefs may function similarly to submerged vegetation. For example, spotted seatrout and red drum appear to favor oyster reefs as foraging areas in much the same way they use seagrass meadows in areas where seagrasses are abundant.

3.2.1.6.2 Distribution in the Gulf of Mexico

Oyster reefs of various sizes are present in all Texas estuaries, but are best developed between Galveston Bay and Corpus Christi Bay (Diener 1975). It is absent throughout most of the Laguna Madre but reappears near Port Isabel and in South Bay. Typically, it is most abundant in mid-bay areas, forming extensive reefs. The majority of Texas oyster reefs (~7,095 ha; 88.3 %) are public (Hal Osburn, Texas Parks and Wildlife Department, personal communication). North of the Brazos River, eastern oysters are found in the intertidal zone; along the central and southern coast, when present, they are most often subtidal (Britton and Morton 1989). Competition for space in the reduced intertidal range of the microtidal bays and severe summer mortalities due to exposure to high temperatures, prevents oyster communities from flourishing.

Oyster reefs in Louisiana coastal waters occur on both public grounds and private leases. Public grounds comprise nearly 2 million acres of water bottoms, although known oyster reefs cover only about 2% (roughly 40,000 acres) of public ground acreage. Although there are nearly 420,000 acres of private leases, it is unknown how many leased acres are comprised of reefs. The majority of public ground reef acreage is found east of the Mississippi River where nearly 35,000 acres (87.5%) are located. Public grounds in Terrebonne Parish comprise nearly 1,800 acres of reefs, while 1,691 acres of public ground reefs are located in Cameron Parish in the Calcasieu Lake Public Tonging Area. All public grounds are managed by the Louisiana Department of Wildlife and fisheries and are opened to harvest on a seasonal basis, generally between September and April (LDWF 2002).

In Mississippi, oyster reefs cover approximately 4,047-4,451 ha. Seventeen natural reefs are managed by the state. There are six private leases ranging in size from 2 to 40.5 ha apiece. About 97% of the commercial harvest comes from western Mississippi Sound, mostly from Pass Marianne, Telegraph, and Pass Christian reefs. In this area of Mississippi Sound, most oyster reefs are subtidal (> 6 feet deep), but some intertidal reefs exist in eastern Mississippi Sound (Mark Van Hoose, personal communication). Some areas, such as St. Louis Bay, have yet to be mapped. In late 2002 a program was begun to distribute 3,950 cubic yards of oyster shell and other suitable cultch material at Telegraph Reef to increase areas where oyster larvae can successfully settle, and enhance oyster production.

Oyster reefs in Alabama are still found in areas such as Mobile Bay, and were historically found in Weeks Bay before high sedimentation rates buried most of them. Some previously productive oyster reefs in Mobile Bay have become unproductive in recent years with one study citing low oxygen events, high sedimentation rates, and limited settlement sites for larvae as the principal causes of the decline (Wallace et al. 2000). Restoration efforts are currently underway.

As measured in the 1995 survey there were 1407.0 hectares of productive public oyster reefs area in the Cedar Point Buoy – Kings Buoy vicinity of Alabama. Adding an additional 489 hectares of Baldwin County – Upper Bay – Portersville Bay reefs gives the state a total of 1896 hectares of mapped oyster reef. There are additional small, scattered patches of oysters especially along the western shore of Mobile Bay in addition to the riparian beds located in Heron Bay and the Mississippi Sound (May 1971; Tatum *et al*. 1996). The average annual harvest over the past ten years has been 650,810 pounds of meat. Hurricanes in 1995, 1997, and 1998 greatly diminished both the oysters and cultch material on Alabama reefs. To partially recoup those losses and to increase overall production, the Alabama Marine Resources Division has planted 100,698 cubic meters of cultch material on state reefs (Mark Van Hoose, Alabama Department of Conservation and Natural Resources, pers. comm.). An additional 15,552 cubic meters planting was funded by a pipeline company. The planted areas have not only produced oysters but also proven extremely popular to recreational fishermen. Species such as tripletail, sand seatrout, and spotted seatrout are regularly harvested off these cultch-enhanced areas.

Although there are nearly 74,465 ha of oyster reefs in Florida only approximately 5,600 ha are open to shell fishing. The other over 68,800 ha are closed to shell fishing because of unacceptable levels of coliform bacteria. Nearly 63% (1,428 ha) of the open area is public and most is located in the panhandle estuaries of Apalachicola Bay and St. George Sound. Eighty-three percent of the natural public reefs on the Gulf Coast are found in Apalachicola Bay (McNulty *et al*. 1972).

3.2.1.6.3 Consequences of alteration

Oyster reefs possess emergent properties, that is, they are more than the sum of their parts. If all the living oysters in a reef were distributed randomly or uniformly within the environment, most of the function and value associated with the oyster reef community would be lost (Bahr and Lanier 1981). Much of the value of the reef lies in its stability as an island of complex intertidal habitat in otherwise soft sediment and its stabilizing influence on erosional processes. The suspension and deposit feeding fauna associated with the reef provide trophic support for higher consumer levels through the conversion of detritus to animal biomass and to the primary producers through mineralization of carbon and release of nutrients like nitrogen and phosphorous. Oyster reefs play a significant role in the energy flow dynamics of the estuaries in which they are found.

Oysters live very close to their stress tolerance threshold, so only small amounts of additional natural or anthropogenic disturbance may destroy the entire reef community (Bahr and Lanier 1981). Direct physical alteration of mature reefs, through harvesting or boat anchoring and prop scarring, at only moderate levels can destroy an oyster reef. Reefs are particularly susceptible to alterations in hydrology due to impoundment or diversion of the coastal rivers or tidal streams. Because reefs are located at the ecotone between wetlands and open water, wetland loss results in loss of oyster reefs, through reduction of the interface zone and decreased macrophytic detritus. Increased freshwater inflow, as well drought, impact oysters. Poor water quality due to contaminants (e.g., heavy metals, hydrocarbons, pesticides), nutrient enrichment (e.g., sewage, fertilizers) or turbidity (e.g., dredging, wastershed devegetation, boat traffic) reduces habitat quality for oysters and may result in their demise. In Galveston and Trinity bays (Texas), many once productive reefs are unharvestable, dead or dying due to bacterial contamination, and/or contamination by chemical and organic pollutants (Britton and Morton 1989). On the positive side, oysters may be able to ameliorate algal blooms associated with eutrophication through their ability to affect distribution and abundance of phytoplankton (Coen *et al*. 1999).

Significant declines in oyster populations along the Atlantic coast during the past century have been implicated in the collapse of some formerly productive fisheries and reduced ecological function (Coen *et al*. 1999). The value of a mature oyster reef lies in its contribution to the function of the estuary as a whole, not in its limited value for the harvest of oysters (Bahr and Lanier 1981). Bahr and Lanier (1981) suggest that only oysters on immature, low intertidal and subtidal reefs should be harvested because oyster growth rates are more rapid and crowding is less. They also stress the importance of efforts to reduce or eliminate human perturbations. There is clear evidence that human disturbance of estuaries results in declines in oysters and the associated community. The effects of reef loss may be both obvious and subtle, but will certainly result in reduced estuarine productivity (Bahr and Lanier 1981, Britton and Morton 1989) that may affect productivity in offshore fisheries.

3.2.2 Offshore habitats

3.2.2.1 Coral reefs

Although not common, several coral reef communities exist in the Gulf of Mexico. Far more common are solitary coral colonies, which exist throughout the Gulf of Mexico. Within the Gulf of Mexico, corals and coral reef communities exist in oceanic habitats of corresponding variability, from nearshore environments to continental slopes and canyons, including the intermediate shelf zones. Corals may dominate a habitat (coral reefs), be a significant component (hard bottom), or be individuals within a community characterized by other fauna (solitary corals).

Geologically and ecologically, the range of coral assemblages and habitat types is equally diverse. The coral reefs of shallow, warm waters are typically built upon coralline rock and support a wide array of hermatypic and ahermatypic corals, finfish, invertebrates, algae, plants and microorganisms. Hard bottoms and hard banks, found on a wider bathymetric and geographic scale, often possess high species diversity but may lack hermatypic corals, the supporting coralline structure, or some of the associated biota (see 3.2.2.2 Live/Hard Bottom). In deeper waters, large elongate mounds called deepwater banks, hundreds of meters in length, often support a rich fauna compared with adjacent areas. Lastly are communities including solitary corals. This category often lacks a topographic relief as its substrate, but may use a sandy bottom instead. Solitary corals are a minor component of the bottom communities and comprise a minor percentage of the total coral stocks in the Gulf of Mexico.

Ecologically and geologically, hard bottoms and hard banks are two diverse categories. Both habitats include corals but typically not the carbonate structure of a patch or outer bank coral reef nor the lithified rock of lithoherms, a type of deepwater bank. Diverse biotic zonation patterns have evolved in many of these communities because of their geologic structure and geographic location.

Coral reefs exist in areas surrounding the Dry Tortugas, an island group about 117 km west of Key West, Florida. The Dry Tortugas reefs form an elliptical atoll-like structure about 27 km long by 12 km wide. Living coral reefs occupied less than 4 percent (4,831 ha (11,933 ac) of the bottom above the 18-m line at the Dry Tortugas in 1976 (Davis 1982). Jaap *et al*. (1989) studied Bird Key Reef in the Dry Tortugas, recording 45 species of stony corals. The most extensive reef type coral was staghorn coral, *Acropora cervicornis*. It covered a total of 478 ha (1,181 ac), and accounted for 55 percent of the scleractinian coral cover. Nearly half the staghorn reef type was concentrated in a single 220 ha (543 ac) reef. This reef was at depths of 6 to 14 m in an area of strong tidal currents. Coral head buttresses occupied a total 251 ha (620 ac). These buttresses occupied only 1.1 percent of the bottom, but they provided shelter for large concentrations of fishes, spiny lobster, *Panulirus argus*, and echinoderms near seagrass and octocoral foraging areas, making them critical elements of the Dry Tortugas system (Davis 1982). The bank reef area accounted for 137 ha (338 ac) of the coral reef hard bottom.

On the shallow flats between the outer reefs and the lagoonal grass beds, a hard bottom community of exposed limestone dominated by octocorals occupied 3,965 ha (9,794 ac) (Davis 1982). On the shallowest portions of the southeastern sides of the major banks, small algal communities occupied a total of 114 ha (282 ac). From 100 to 250 m seaward, the sea floor is a mosaic of low relief, limestone outcroppings interspersed with carbonate sediments. The limestone outcroppings support a diverse assemblage of sessile reef organisms.

The East and West Flower Garden Banks are located on the outer edge of the continental shelf, approximately 193 km and 172 km southeast of Galveston, Texas. The banks are topographic prominences of bedrock uplifted by the underlying salt diapirs. The bedrock is capped with a relatively thin layer of calcareous reef building organisms. The Flower Gardens are the two largest of more than 130 calcareous banks charted in the northwest Gulf of Mexico that exhibit topographic elevation above an otherwise smooth continental shelf (Bright *et al*. 1985).

The Flower Garden Banks are considered near the northern physiological limits for tropical hermatypic corals in the Gulf of Mexico and are the northernmost thriving tropical coral reefs on the North American continental shelf (Rezak *et al*. 1985). The banks are not considered diverse and only 18 of the 65 western Atlantic hermatypic coral species occur on the Flower Garden Banks (Gittings *et al*. 1992a). The presence and extent of reef building activity on the Flower

Garden Banks is due to favorable conditions of substrate, water depth, temperature, salinity, and water clarity.

The East Flower Garden Bank is pear shaped and covers an area of approximately 6,700 ha (16,500 ac) (Rezak *et al*. 1985). Topographic relief is pronounced on the east and south sides of the bank and gentle on the west and north sides. The shallowest depth on the bank is approximately 20 m and surrounding water depths range from approximately 100 to 120 m.

The West Flower Garden Bank lies 12 km west of the East Flower Garden Bank and is characterized by three main crests separated by grabens that are aligned parallel to the long axis of the underlying diapiric core. The bank covers an area of approximately 13,700 ha. The shallowest depth on the West Flower Garden Bank is approximately 15 m. Surrounding water depths vary from 100 to 150 m.

Very recent surveys by the Flower Garden Banks National Marine Sanctuary and collaborators are further characterizing the other reefs and banks of the northwestern Gulf of Mexico that were first studied by Rezak *et al.* (1985). Preliminary data is documenting the occurrence of coral communities that are more extensive than previously known (G.P. Schmahl, letter to the Council, Oct 2003). Significant coral resources are found at Stetson, McGrail, Bright, Geyer, Sonnier, and Claypile Banks. Additionally, these areas contain significant communities of a variety of antipitharians, solitary corals and branching corals such as *Oculina* and *Madrepora*. As mapping and research efforts continue, these areas currently mapped as hardbottom communities (Fig. 3.1.3) may be reclassified as living coral reefs similar to the Flower Garden Banks and Tortugas.

A newly studied deep reef named Pulley Ridge consists of a series of north-south oriented, drowned barrier islands on the southwest Florida shelf about 250 km west of Cape Sable (Jarrett 2003). The ridge is 100+ km long and approximately 5 km across feature with less than 10 m of vertical relief and an abundance of mounds and pits. At the structures shallowest end in the southern portion (60 m deep) a variety of living coral reef organisms are found: scleractinian corals; octocorals; green, red, and brown algae; sponges; coralline algae; and tropical reef fishes (Jarrett 2003). The corals found most commonly on Pulley Ridge were *Agaricia* spp. and *Leptoceris cucullata*, and other corals include *Montastrea cavernosa, M. formosa, M. decactis, Porites divaricata,* and *Oculina tellena*. Beyond 80 m, coralline algae increases in abundance, while coral abundance diminishes. Reef fishes associated with the living reef area include FMP species like red grouper, scamp, and sand tilefish; as well as typical reef residents like butterfly fishes and angelfishes. About 25% of the reef fish community consists of herbivores (Jarrett 2003).

The unusual benthic productivity on Pulley Ridge, between 60 and 70 m, is probably due to the underlying drowned barrier islands which provide an elevated lithified substrate for the attachment of benthic organisms; the clear warm water that the area receives from the western edge of the Florida Loop Current, and its location within the thermocline which provides extra nutrients (Jarrett 2003). Hermatypic corals and photosynthetic organisms on the ridge survive on only 1-2% of the available surface light, while most shallow reef communities require at least 5%. Jarrett (2003) proposes that Pulley Ridge may be the deepest coral reef in the U.S., although it does not adhere to the strict geological definition of a coral reef. The USGS and university scientists are currently studying the area. This study is expected to last at least until mid 2005. For the purposes of this EIS the area is being classified as living hard bottom. This will be re-visited during future reviews of EFH and HAPC once the current studies provide new information that can be used to either confirm or modify the classification.

Due to its location, this reef /hard bottom area is not affected by temperature changes, increased turbidity, and nutrient overload like the shallower reefs found to the east (Hallock and Schlager 1986).

3.2.2.2 Live/hard bottom

Hard bottoms constitute a group of biological communities characterized by a thin veneer of live corals and other biota overlying assorted sediment types. They are generally dominated by epifaunal organisms such as sponges, hard and soft corals, hydroids, anemones, barnacles, bryozoans, decapod crustaceans and gastropods. Many species of reef fish in the Reef Fish FMP assemblages aggregate or associate with various hard bottom communities at some stage of their adult life. Hard bottoms on banks are topographic highs or salt domes created by geologic uplifting. They have vertical relief measured in tens of meters. On the continental shelf, hard bottoms are usually of low relief and many are associated with relict reefs where the coral veneer is supported by dead corals.

3.2.2.2.1 The West Florida shelf

The extensive emergent substrate that makes up the west Florida shelf (see Section 3.1.1.3) supports the growth of coralline algae at mid-shelf depths (60 to 80 m), which creates algal nodules and a crustose algal pavement, allowing the development of deepwater hermatypic corals. The coralline algal nodule and algal pavement/*Agaricia* assemblages represent the closest development of an active reef habitat on the shelf. Whether consisting of exposed or thinly covered hard bottom, the remaining hard bottom areas are scattered across the broad shelf. They are generally colonized by seasonal algae, sponges, and other filter feeders of mixed warm temperature and tropical affinities. The tropical biota consists primarily of the hardier, more tolerant forms, like the hard corals *Siderastrea* sp. and *Solenastrea* sp.

The west Florida shelf has been described by Woodward-Clyde Consultants, Inc. (1984), who grouped the benthic communities based on shared similarities and dissimilarities. The assemblages are:

- Inner Shelf Live Bottom Assemblage I - this live bottom biological assemblage consisted of patches of various algae (*Caulerpa* spp., *Halimeda* spp., and *Udotea* spp.), ascidians, hard corals (Siderastrea spp.), large gorgonians (*Eunicea* spp., *Muricea* spp., *Pseudoplexaura* spp., and *Pseudopterogorgia* spp.), hydrozoans, and sponges (*Geodia gibberosa*, *G. neptuni*, *Haliclona* spp., *Ircinia campanal* and *Spheciospongia vesparium*). Individual organisms were generally larger, and the fauna appeared to exhibit a higher biomass per unit area, than in the Inner and Middle Shelf Live Bottom Assemblage II.

Woodward-Clyde Consultants, Inc. (1984) identified this assemblage in water depths of 20 to 27 m.

- Inner and Middle Shelf Live Bottom Assemblage II - this live bottom biological assemblage consisted of algae (*Cystodictyon pavonium*, *Halimeda* spp., and *Udotea* spp.), ascidians (*Clavelina gigantea*), bryozoans (*Celleporaria* spp. and *Stylopoma spongites*), hard corals (*Cladocora arbuscula*, *Scolymia lacera*, *Siderastrea* spp., and *Solenastrea hyades*), small gorgonians, hydrozoans, and several sponges (*Cinachyra alloclada*, *Geodia gibberosa*, *G. neptuni*, *Ircinia* spp., *Placospongia melobesioides*, and *Spheciospongia vesparium*). This assemblage has a higher number of sponges and a lower biomass per unit area than the Inner Shelf Live Bottom Assemblage I. Woodward-Clyde Consultants, Inc. (1984) identified this assemblage in water depths of 25 to 75 m.

- Middle Shelf Algal Nodule Assemblage - this assemblage consisted of coralline algal nodules formed by *Lithophyllum* spp. and *Lithothamnium* spp., combined with sand, silt, and clay particles. Algae (*Halimeda* spp., *Peyssonnelia* spp., and *Udotea* spp.), hard corals and small sponges (*Cinachyra alloclada* and *Ircinia* spp.) were also present. Woodward-Clyde Consultants, Inc. (1984) identified this assemblage in water depths of 62 to 108 m.

- *Agaricia* Coral Plate Assemblage - this biotal assemblage consisted of a dead, hard coral-coralline algae substrate covered with living algae (*Anadyomene menziesii* and *Peyssonnelia* spp.), live hard corals (*Agaricia* spp. and *Madracis* spp.), gorgonians, and sponges. Woodward-Clyde Consultants, Inc. (1984) identified this assemblage in water depths of 64 to 81 m.

- Outer Shelf Crinoid Assemblage - this assemblage consisted of large numbers of crinoids (*Comactinia meridionalis*, *Neocomatella pulchella*, and *Leptonemaster venustus*) living on a coarse sand or rock rubble substrate. Small hexactinellid sponges may also be associated with this assemblage. Woodward-Clyde Consultants, Inc. (1984) identified this assemblage in water depths of 118 to 168 m.

- Outer Shelf Low Relief Live Bottom Assemblage - this live bottom assemblage consisted of various octocorals (including *Nicella guadalupensis*), the antipatharian corals *Antipathes* spp., *Aphanipathes abietina*, *A. humilis*, occasional hard corals (including *Madrepora carolina*), crinoids, the hydrozoan *Stylaster* sp., and small sponges in the Order Dictyonina. It was found in conjunction with low relief rock surfaces with a thin sand veneer. Woodward-Clyde Consultants, Inc. (1984) identified this assemblage in water depths of 108 to 198 m.

- Outer Shelf Prominences Live Bottom Assemblage - this biological assemblage consisted of the gorgonian *Nicella guadalupensis*, the antipatharian corals *Antipathes* spp., *Aphanipathes abietina*, *A. filix*, and *A. humilis*, the hard coral *Madrepora carolina*, crinoids, the hydrozoan *Stylaster* sp., and medium to large hexactinellid sponges in the Order Dictyonina. All of these organisms were found on rock prominences. These prominences generally emerged from a sand-covered bottom and had a vertical relief of up to 2 m. These prominences are most likely dead coral pinnacles. Woodward-Clyde Consultants, Inc. (1984) identified this assemblage in water depths of 136 to 169 m.

The Florida Middle Ground is the best-known and most important area on the west coast of Florida, in terms of coral communities. However, at present, the area has been described as a hard bottom rather than a coral reef because live corals contribute little to the configuration of the area (Smith 1976).

Of the corals that do exist in the Florida Middle Ground, the hydrozoan coral *Millepora* sp. is believed to be the main frame builder (also discussed in Section 3.2.2.2.1), although populations of hermatypic scleractinians (*Porites*, *Dichocoenia*, *Madracis*) are present at the upper depth ranges (26 to 30 m). Shallow-water alcyonaceans (*Muricea*, *Plexaura*, *Eunicea*) are also present, and the fauna bears a distinct dissimilarity to that of the Flower Garden Banks. Although the Florida Middle Ground provides a high-relief substratum for reef biota, its location is apparently too far northward to allow the establishment of massive hermatypic coral assemblages. Winter water temperatures can reach 15^o to 16^o C, and hermatypic corals require temperatures of 18^o to 30^o C for viable existence. Significantly productive areas in the Florida Middle Ground comprise about 12,100 ha (29,900 ac) (Woodward-Clyde Consultants, Inc. 1984).

The hydrozoan coral *Millepora alcicornis* forms massive colonies along the rocky margins at about 27 m depth (Hopkins *et al*. 1977). *Millepora alcicornis* is the major contributor to frame building on the Fbrida Middle Ground. The dominant scleractinians in the Florida Middle Ground include *Madracis decactis*, *Porites divaricata*, *Dichocoenia stellaris*, *D. stokesii*, and *Scolymia lacera*. Octocorals, a relatively minor component of other Gulf reefs, are prominent on the Florida Middle Ground. Dominant forms of octocorals include *Muricea elongata*, *Muricea laxa*, *Eunicea calyculata*, and *Plexaura flexuosa*.

A species zonation pattern exists on the Florida Middle Ground with overlap between adjacent zones. Grimm and Hopkins (1977) describe a *Muricea-Dichocoenia-Porites* zone at 26 to 28 m. From 28 to 30 m the dominant forms are *Dichocoenia* and *Madracis*. *Millepora* dominates from 30 to 31 m but becomes co-dominant with *Madracis* from 31 to 36 m.

The waters of Tampa Bay on the north and Sanibel Island on the south bound another west Florida shelf region with notable coral communities. The area consists of a variety of bottom types. Rocky bottom occurs at the 18 m isobath where sponges, alcyonarians, and the scleractinians *Solenastrea hyades* and *Cladocora arbuscula* are especially prominent.

The west Florida shelf has long been recognized as an area that supports commercially important fish and shellfish populations, an importance attributed at least in part to the abundance of scattered rock outcrops and sponge bottoms that provide fish habitat (Darcy and Gutherz 1984). One hundred seventy species of fish from 56 families have been observed or collected on the Florida Middle Ground. Of these, 97 species are considered primary reef fish and 45 species as secondary reef fish (Hopkins *et al*. 1977). Commercially important species include striped mullet, *Mugil cephalus*, spotted sea trout, *Cynoscion nebulosus*, Spanish mackerel, *Scomberomorus maculata*, king mackerel, *S. cavalla*, Florida pompano, *Trachinotus carolinus*, snappers, *Lutjanus* spp., and groupers, *Epinephelus* spp. and *Myctoperca* spp., several of which are primarily nearshore/estuarine inhabitants. The most species families of demersal fishes on the shelf are the left eye flounders (Bothidae), sea basses (Serranidae), drums (Sciaenidae), and searobins (Triglidae) (Darcy and Gutherz 1984).

3.2.2.2.2 The Mississippi-Alabama shelf

The northeastern portion of the Central Gulf of Mexico exhibits a region of topographic relief, known as the "pinnacle trend," at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and DeSoto Canyon. The pinnacles appear to be carbonate reefal structures in an intermediate stage between growth and fossilization (Ludwick and Walton 1957). The region contains a variety of features from low-relief rocky areas to major pinnacles, as well as ridges, scarps, and relict patch reefs (see Section 3.1.1.4). The heavily indurated pinnacles provide a surprising amount of surface area for the growth of sessile invertebrates and attract large numbers of fish. Additional hard-bottom features are located nearby on the continental shelf, outside the actual pinnacle trend.

The features of the pinnacle trend offer a combination of topographic relief, occasionally in excess of 20 m, and hard substrate for the attachment of sessile organisms and, therefore, have a greater potential to support significant live-bottom communities than surrounding areas on the Mississippi-Alabama Shelf. This potential to support live-bottom communities has made these features a focus of concern and discussion. The species composition of the pinnacle trend has been compared to the Antipatharian Zone and Nepheloid Zone described by Rezak and Bright (1978) and Rezak (CSA 1985). The following description of the pinnacle-trend region is found in the Mississippi-Alabama Continental Shelf Ecosystems Study: Data Summary and Synthesis, as described by Brooks (1991).

> Biological assemblages dominated by tropical hard bottom organisms and reef fishes occupy a variety of topographic features that exist between 53 and 110 m in the northeastern Gulf of Mexico between the Mississippi River and DeSoto Canyon. The origins of the carbonate features vary. Some are small, isolated, low to moderate [relief] reefal features or outcrops of unknown origin. Some appear to be hard substrates exposed by erosion during sea level still-stands along late Pleistocene shorelines. Others appear to be small reefs that existed near these shorelines. The largest reefal features appear to have been offshore reefs. The structure of the summits of some reefs may also have been modified by Holocene erosional events following their initial period of growth (namely, the flat-topped reefs). Most appear to be deteriorating under the influence of bioerosional processes. Hard bottoms and associated organisms are evident on at least two salt domes within 50 km of the Mississippi River Delta.
>
> The hermatypes that contributed to the development of these structures probably included coralline algae, reef-building corals, bryozoans, foraminiferans, and molluscs, among others. Present-day production of calcium carbonate is probably limited to an impoverished calcareous alga population on features cresting above 78 m (shallower in most areas). Features below this depth can most likely be considered completely drowned reefs.

> Present-day biological assemblages on features in the Northeastern Gulf are dominated by suspension feeding invertebrates. Populations are depauperate on features of low topography, those in habitats laden with fine sediments, and at the base of larger features (where resuspension of sediments limits community development). On larger features the diversity and development of communities appears to depend on habitat complexity; that is, the number of habitat types available to hard bottom organisms, and to some extent, the distance from the Mississippi River Delta. On reefs containing extensive reef flats on their summits, there are rich assemblages distinguished by a high relative frequency of sponges, gorgonian corals (especially sea fans), crinoids, and bryozoans. Due to the generally accordant depth of flat-topped reefs (62-63 m), coralline algae are also in abundance. Other organisms on reef flats include holothurians, basket stars, and myriads of fish (mostly, *Holanthias martinicensis* [roughtongue bass], *Hemanthias aureorubens* [streamer bass], and *Rhomboplites aurorubens* [vermilion snapper]). On reefs lacking this reef flat habitat, as well as on reef faces of flat-topped features, the benthic community is characterized by a high relative abundance of ahermatypic corals (both solitary and colonial scleractinians). Other frequently observed organisms on these rugged, often vertical reef faces include crinoids, gorgonians, sea urchins, and basket stars. Among other species, dense schools of *H. martinicensis, H. aureorubens* (streamer bass) and *Paranthias furcifer* (creole fish) often occupy their summits.
>
> Biological abundance and species diversity increase in relation to the amount of solid substrate exposed and to the variety of habitats available. Thus, low biological abundance and diversity characterize low relief features 2 m high. Features of intermediate relief (2-6 m high) may exhibit low or high abundance and diversity depending upon habitat complexity. High relief features (>6 m) have dense and diverse biotas whose composition varies with habitat type (i.e., flat reef tops vs. ragged reef sides). Depth in the water column appears not to play a major role in determining species composition except in the case of coralline algae, which have not been encountered below a depth of 78 m. Since most of the major species are suspension feeders, susceptibility to sedimentation does appear to limit species composition. Areas closest to the Mississippi River Delta are most affected, and this influence extends eastward for up to 115 km (70 miles) from the Delta. Living hermatypic corals have not been observed on topographic features of the Mississippi-Alabama shelf.

Brooks (1991) found the areas of high relief to have higher population densities and a higher diversity than the surrounding low relief areas. Brooks (1991) also recognized longitudinal variation in the diversity in the pinnacle trend area. Areas closer to the Mississippi River were lower in diversity than areas farther to the east. He concluded that the Mississippi River plume influences the long term average water quality (salinity and turbidity) over the pinnacle trend area, resulting in diminished developmental potential on features closer to the river delta. Gittings *et al*. (1992b) reached similar conclusions.

Based on the findings of Brooks (1991), the most significant aspect of the hard bottoms and topographic features of the Mississippi-Alabama shelf lies in the fact that they form part of a chain of such features lying at comparable water depths around the entire rim of the Gulf of Mexico supporting similar biological communities. Located in a central position, the topographic features possibly facilitate genetic exchange between the faunas of such communities both to the east and west (Brooks 1991). Lying directly in the path of Loop Current intrusions, these are likely the first hard bottom communities to be encountered by species transported from the Caribbean. Thus, they may at times serve as centers of dispersal for successful colonizers from the tropics. The presence of the Mississippi-Alabama hard banks may serve the function of "island hopping" for important reef species and may present the key habitat link between the reef fauna of the northwestern and northeastern Gulf of Mexico. In these respects the hard bottoms and topographic features are important in terms of the larger Gulf of Mexico ecosystem as a whole.

Vertical relief of individual hard bottom features is the single most significant factor influencing live bottom community development. All of the major live bottom studies conducted in the northeastern Gulf have demonstrated higher frequencies of occurrence and higher numbers of species with increasing vertical relief (Shipp and Hopkins 1978; Schroeder *et al*. 1988a; Brooks 1991; Continental Shelf Associates, Inc. 1992; Gittings *et al*. 1992b).

The invertebrate faunal observations by Shipp and Hopkins (1978) included two distinct areas that support low diversity communities of an apparently mixed tropical and temperate nature. The first was the sand-shell-coralline-algae slope immediately above and below the block ridges of limestone and the block substrate of the ridges. Two forms of attached pennatulaceid coelenterates, decapod crustaceans and asteroid echinoderms were encountered at the sand-shell-coralline-algae slope. There was also evidence of bioturbation by worms and molluscs that were not directly observed. Sponges, scleractinians, octocorals, solitary antipatharians, and some hydroids colonized the rocky ridges. Majid crabs, hermit crabs, whelks, and sea cucumbers were also present.

The species composition in the pinnacle trend area is comparable to the Antipatharian Zones and the Nepheloid Zones (Brooks 1991). Features were also present that represented an Algal-Sponge Zone. Some pinnacles have considerable amounts of crustose coralline algae.

Continental Shelf Associates, Inc. (1992) also conducted geological and biological investigations of the pinnacle trend area. The biological communities present on the features were antipatharians, ahermatypic hard corals, comatulid crinoids, sponges, alcyonarians, and hydroids. Coralline algae were also present in water depths less than 72 m. They concluded water depth precluded the growth of coralline algae on all but the upper portions of the tallest features. A variety of epifaunal organisms were also found, including crinoids, urchins, gorgonacephalids, and fireworms. Fishes observed on the pinnacles included vermilion snapper, *Rhomboplites aurorubens*, red porgy, *Pagrus pagrus*, amberjack, *Seriola dumerili*, tattler, *Serranus phoebe*, red snapper, *Lutjanus campechanus*, dolphin, *Coryphaena hippurus*, gag, *Mycteroperca microlepis*, short bigeye, *Pristigenys alta*, Spanish flag, *Gonioplectrus hispanus*, and other small plankton feeders such as anthids.

The geologic components of a four-year study characterizing and monitoring carbonate mounds on the Mississippi-Alabama outer continental shelf (OCS) is presented in Section 3.1.1.4 (CSA and GERG 2001). The biological communities associated with five of the nine sites are described as follows:

- Site 5: There are distinct assemblages of organisms in different locations on these features. Organisms found on top of the large feature were family *Stenogorgiinae*, *Swiftia exserta*, *Stichopathes lutkeni*, *Antipathes* spp., *Bebryce cinera/grandis*, *Ctenocella* (*Ellisella*) spp., *Hypnogorgia pendula*, and other unidentified gorgonian corals. Hermatypic as well as ahermatypic corals were sparsely distributed on the top interior probably due to heavy accumulations of fine sediments. *Rhizopsammia manuelensis* was the dominant species on almost all surfaces of the smaller mounds associated with the feature. Other species found on the vertical face of the main feature and adjacent mounds included *Madracis/Oculina* sp., *Madrepora carolina*, *Antipathes* spp., and *Stichopathes lutkeni*. Also present were the sea urchins *Stylocidaris affinis* and *Diadema antillarum*, a few unidentified sponge species, and small colonies of bryozoans.
- Site 6: There was a low-diversity biological community observed on these low-relief features. The most noticeable taxa include *Bebryce cinerea/grandis*, *Thesea* spp., *Ctenocella* (*Ellisella*) spp., *Antipathes*, and *Stichopates lutkeni*. *Rhizopsammia manuelensis* was relatively common on the few features with more than 1 m of relief, and *Madracis/Oculina* sp. and *Madrepora carolina* were also occasionally observed.
- Site 7: There is a distinct difference between the community on the flat top of the structure and that associated with the sloping sides and flanks. Biota observed on the top of the feature include *Bebryce cineriea/grandis*, *Ctenocella* (*Ellisella*) spp., *Nicella* spp., crinoids, *Antipathes* spp., *Stichopathes lutkeni*, coralline algae, several species of sponges; *Astrocyclus caecilia*, and *R. manuelensis*. The occurrence of *R. manuelensis* on the top of Site 7 may be due to the less uniform topography at this site. The species does not appear in the areas of lowest relief atop the feature. On the edges, sides, and adjacent rock structures, *R. manuelensis* is the dominant epibiota, with crinoids, *Antipathes* spp., *Stichopathes lutkeni*, coralline algae (down to approximately 76 m), *Madracis/Oculina* sp., the unidentified solitary scleractinian, and several sponges also observed. Along the exposed edges of the large rock overhangs, *Madracis/Oculina* sp. and unidentified scleractinian were abundant. In the areas of scattered shell and rubble surrounding the feature are crinoids, with small colonies of *Antipathes* spp. also in evidence.
- Site 8: *Rhizopsammia manuelensis* was evident on the entire structure from just above the base to the top, with lower densities observed on horizontal surfaces with a heavier silt accumulation. Other observed epibiota included the *Ctenocella* (*Ellisella*) spp., *Hypnogorgia pendula*, *Nicella* spp., *Thesea* spp., *Antipathes* spp., *Stichopathes lutkeni*, and *Madrepora carolina*. There is no obvious zonation of any of these taxa except for higher abundances of *Hypnogorgia pendula* occurring near the top of the feature. The arrow crabs, *Stenohynchus seticornis* and *Astrocyclus caecilia*, crinoids, and the sea urchins *Diadema antillarum* and

Stylocidaris affinis were also observed on the mounds. The species colonizing the lower relief mounds appear similar in composition to those on the primary feature.

- Site 9: Biota on the lower relief structures includes *Bebryce cinerea/grandis, Hypnogorgia pendula*, *Nicella* spp., *Swiftia exserta*, *Thesea* spp., *Ctenocella (Ellisella*) spp., *Antipathes* spp., *Madrepora carolina,* and occasional crinoids. *Ctenocella (Ellisella*) spp. had substantially higher abundances at this site than the other surveyed sites especially on the low-relief rock outcrops. Some smaller mounds (1 m in height) had few colonies of *R. manuelensis*; however, the larger mounds had very high numbers of *R. manuelensis* on the upper 2-3 m of the structure, along with larger octocoral fans.

Brooks (1991) identified 70 fish species associated with the topographic high habitats. Thirty-five of these species were taken by bottom trawls during sampling and are listed as soft bottom species. The remaining 35 species seem unique to this habitat.

The fish fauna of the DeSoto Canyon rim, recorded by Shipp and Hopkins (1978), were dominated by families characteristic of Caribbean reefs. Sea basses (Serranidae) and damselfishes (Pomacentridae) comprised the most visibly abundant components. Also present in large numbers were the cardinal fishes (Apogonidae), butterflyfishes (Chaetodontidae), bigeyes (Priacanthidae), drums (Sciaenidae), squirrelfishes (Holocentridae), and snappers (Lutjanidae). Grunts (Pomadasyidae) and porgies (Sparidae) were represented but the sightings were sporadic.

In assessing the overall health of the pinnacle trend live bottoms; Brooks (1991) concludes the following:

> Human impact in these environments appears to be minimal. Discarded debris or lost fishing gear (such as longlines), though present at many sites, was not abundant, and therefore poses little threat to the environment. Cables and lines can affect shallower reef communities, but probably have little impact at these depths once they become tangled on or lodged against reef structures. Fishing pressure on these relatively small features may reduce the population of the larger, commercially important species, and may explain the frequency of smaller individuals of unprofitable species on heavily fished reefs.

3.2.2.2.3 The Louisiana-Texas shelf

Vertical relief of the banks on the Louisiana-Texas Shelf varies from less than one meter to over 150 m. These banks exist in water depths of 22 to 300 m. Putt *et al*. (1986) examined six shallow water (<35 m) hard bottom sites off the coast of central Louisiana. These were areas of low relief from one to three meters. These hard bottom areas were generally enveloped in a dense nepheloid layer. The associated sessile epibiota included hydroids, bryozoans, ascidians, encrusting sponges, and some ahermatypic stony corals. Common fish species included Atlantic spadefish, *Chaetodipterus faber*, red snapper, *Lutjanus campechanus*, sheepshead, *Archosargus* *probatocephalus*, gray triggerfish, *Balistes capriscus*, blue runner, *Caranx crysos*, vermilion snapper, *Rhomboplites aurorubens*, rock hind, *Epinephelus adscensionis*, grouper, *Mycteroperca sp.*, and tomtate, *Haemulon aurolineatum*.

These sites differed in their relief and the area covered by each outcropping. The smallest outcropping had an area of approximately 20 m^2. The largest outcropping had an area of several hundred square meters, and some were in the form of a low relief, narrow (< 3 m wide) ridge of rock outcrops running in an east-west direction for a distance of at least 76 m.

Three deepwater hard bottom areas in water depths of 43 to 58 m were also examined by Putt *et al.* (1986). The relief of these features extended above the nepheloid layer and is colonized by more tropical assemblages of invertebrates and fishes. The peak of one feature was within 18 m of the surface. Rock outcrops in the forms of ridges and hummocks were observed atop the feature, with relief ranging from 3 to 5 m.

The epibiota of these areas included bryozoans, hard corals, octocorals, fire corals, sponges, sea whips, gastropods, hydroids, sea urchins, and spiny lobsters. Over 47 species of fish were identified with the major species being greater amberjack, *Seriola dumerili*, vermilion snapper, *Rhomboplites aurorubens*, bigeye, *Priacanthus furcifer*, blue runner, *Caranx crysos*, blue angelfish, *Holacanthus bermudensis*, French angelfish, *Pomacanthus paru*, queen angelfish *Holacanthus ciliaris*, spotfin butterflyfish, *Chaetodon ocellatus*, and yellowtail reeffish, *Chromis enchrysurus*. Large schools, often including hundreds of individuals, of amberjack, tomtate, blue runner, and vermilion snapper were observed above the peak of one hard bottom feature.
The biotic assemblages that occupy the North Texas-Louisiana mid-shelf banks are distinct and compose a *Millepora*-Sponge Zone dominated by hydrozoan fire corals and various sponges (Rezak *et al*. 1985). Rezak *et al*. (1985) found numerous species of fish at the mid-shelf banks. These included yellowtail reef fish, *Chromis enchrysurus*, bluehead, *Thalassoma bifasciatum*, hogfishes, *Bodianus* spp., creole-fishes, *Paranthias furcifer*, rock hind, *Epinephelus adscensionis*, groupers, *Mycteroperca* spp., and others typical of submerged reefs and banks in the northwestern Gulf. Large schools of vermilion snapper, *Rhomboplites aurorubens*, were seen above 35 m depth, and schools of red snapper, *Lutjanus campechanus*, were encountered near the base of most banks. Dennis and Bright (1988) found the reef fish community on mid-shelf banks to be quite diverse with 76 species observed with 51 being primary reef species.

The other category of banks is the shelf-edge carbonate banks and reefs located on complex diapiric structures. They are carbonate caps that have grown over outcrops of a variety of Tertiary and Cretaceous bedrock and salt dome caprock. Although all of the shelf-edge banks have well-developed carbonate caps, local areas of bare bedrock have been exposed by recent faulting on some banks. Relief on shelf-edge banks ranges from 35 to 150 m. Some of the named shelf-edge banks are East Flower Garden Bank, West Flower Garden Bank, Geyer Bank, Rankin Bank, Elvers Bank, MacNeil Bank, Appelbaum Bank, Bright Bank, McGrail Bank, Alderdice Bank, Rezak Bank, Sidner Bank, Ewing Bank, Jakkula Bank, Bouma Bank, Parker Bank, Sackett Bank, Diaphus Bank, and Sweet Bank.

The Algal-Sponge Zone assemblage is the most important clear water community on shelf edge banks (Rezak *et al*. 1985). This assemblage is indicative of year round tropical/subtropical oceanic conditions. Although, a high diversity assemblage (*Diploria-Montastrea-Porites* Zone), limited to depths of 36 m, and a comparatively low diversity assemblage (*Stephanocoenia-Millepora* Zone), between 36 and 52 m, exists on the East and West Flower Garden Banks.

The fish associated with the shelf-edge banks is extremely diverse. Excluding the Flower Garden banks, ninety-five species of reef fish were observed on the shelf-edge banks by Dennis and Bright (1988) with 69 species being classified as primary reef species. Dennis and Bright (1988) found several species that were found exclusively on the shelf-edge banks. The Texas shelf is similar to the Louisiana shelf because it is broad without much relief. There are also areas of carbonate banks, but only a few today display active coral growth because of Holocene sediment cover, lack of sunlight penetration and cold water in the winter months. However, very recent studies by the Flower Garden Banks National Marine Sanctuary and collaborators are further characterizing these reefs and bank. Preliminary data is documenting the occurrence of coral communities that are more extensive than previously known (G.P. Schmahl, letter to the Council, Oct 2003, see also Section 3.2.2.1).

3.2.2.2.4 Shelf-edge banks

The shelf-edge banks of the Western and Central Gulf generally exhibit the *Diploria-Montastraea-Porites* zonation that is exhibited at the East and West Flower Garden Banks at comparable depths. However, Geyer Bank (37-m crest), which is within the depth of the high-diversity, coral-reef zone, does not exhibit the high-diversity characteristics. Instead, Geyer Bank has a well-developed *Millepora*-Sponge Zone, which is typically the defining characteristic of midshelf banks found elsewhere in the Gulf of Mexico (see also discussion in Section 3.2.2.1).

3.2.2.2.5 Midshelf banks

Five midshelf banks contain the *Millepora*-Sponge Zone: Sonnier, 29 Fathom, and Fishnet Banks in the Central Gulf; and Stetson and Claypile Banks in the Western Gulf. The nepheloid layer often enfolds Claypile Bank, considered a low-relief bank with only 10 m of relief. Therefore, the level of development of the *Millepora*-Sponge community is lowest at Claypile Bank. Two other midshelf banks in the Western Gulf (32 Fathom Bank and Coffee Lump) are also low-relief banks with less than 10 m of relief.

Stetson Bank is isolated from other banks by waters over 50 m and lies near the northern physiological limit for the advanced development of reef-building, hermatypic corals. Although part of the Flower Garden Banks National Marine Sanctuary, the species composition at Stetson Bank is markedly different from that of the Flower Garden Banks. In addition to the *Millepora*-Sponge characteristics at Stetson Bank, there are sparsely distributed hermatypic and ahermatypic coral species found there. *Madracis decactus*, *Agaricia fragilis*, (ahermatypic corals), *Stephenocoenia michelinii*, and *Diploria strigosa* (hermatypic corals) are among the most dominant coral species found at Stetson Bank. In addition to Stetson's unique landscape and topographic features, there is a large distribution of marine life residing at the bank. Over 140 species of reef and schooling fishes, 108 mollusks, and 3 predominant echinoderms are reported. Due to its vertical orientation, Stetson attracts a number of pelagic species that move back and forth across the continental shelf utilizing various banks, including the Flower Gardens, for seasonal feeding, mating, and as nursery ground. These large pelagic animals include species such as manta and devil rays and the filter-feeding whale shark.

3.2.2.2.6 South Texas banks

The South Texas banks are geographically/geologically distinct from the shelf-edge banks. Several of the South Texas banks are also low-relief banks. These banks exhibit a reduced biota and have relatively low relief, few hard-substrate outcrops, and a thicker sediment cover than the other banks.

It has been suggested that four other South Texas features in the Western Gulf be considered as sensitive offshore topographic features: Phleger, Sebree, and Big and Small Adam Banks. Phleger Bank (a shelf-edge bank) crests at 122 m, deeper than the lower limit of the No Activity Zones (85 m [100 m in the case of the Flower Gardens]). The depth of the bank precludes the establishment of the Antipatharian Zone so that even though the bank is in clear water, the biota is typical of the nepheloid zone. The bank appears to be predominantly covered with sand, with scattered rock outcrops of approximately 1-2 m in diameter and 1 m in height. The sand substrate is devoid of sessile benthic organisms, although the rock outcrops support a number of epifaunal species such as cup-shaped and encrusting sponges, octocorals, and crinoids. Roughtongue bass were observed in video surveys to be the dominant fish species on this bank. Sebree Bank, located in 36.5 m of water, is a low-relief feature of approximately 3 m in relief and is located in an area subject to high sedimentation. Clusters of the scleractinian coral, *Oculina diffusa*, have been observed on the rocky outcrops of this bank. This species tends to thrive in habitats exhibiting low light and high sedimentation. It forms twisted, rather low-relief colonies, and does not create reefs or distinctive assemblages of reefal species.

Phleger bank attracts abundant nektonic species, including red snapper and other commercially and recreationally important finfish (Tunnell 1981). Findings in the August 1993 cooperative dive effort on Sebree Bank by MMS, the State of Texas, and Texas A&M University at Corpus Christi (Dokken *et al*. 1993) were generally consistent with those reported by Tunnell (1981).

Groundfish populations at the south Texas banks are similar in composition and magnitude to those of the northwestern Gulf (Rezak *et al*. 1985). The most common fish discovered by Rezak *et al*. (1985) were the yellowtail reef fish, *Chromis enchrysurus*, roughtongue bass, *Holanthias martinicensis*, spotfin hogfish, *Bodianus pulchellus*, reef butterflyfish, *Chaetodon sedentarius*, wrasse bass, *Liopropoma eukrines*, bigeye, *Priacanthus sp.*, tattler, *Serranus phoebe*, hovering goby, *Ioglossus calliurus*, and the blue angel fish, *Holocanthus bermudensis*. Few large groupers of the genus *Mycteroperca* or hinds of the genus *Epinephelus* were observed on the south Texas mid-shelf banks. Larger migratory fish were also observed. These included schools of red snapper, *Lutjanus campechanus*, and vermilion snapper, *Rhomboplites aurorubens*. Also present were the greater amberjack, *Seriola dumerili*, the great barracuda, *Sphyraena barracuda*, small carcharhinid sharks, and cobia, *Rachycentron canadum*. Dennis and Bright (1988) observed 66 species of fish on the south Texas banks with 42 species being primary reef species.

Dokken *et al*. (1993) compared the nepheloid dominated, low-diversity community of Sebree Bank with the nepheloid zone community described by Rezak *et al*. (1985). Rezak and Bright

(1981) devised an environmental priority index to rate the sensitivity of topographic features in the northern Gulf of Mexico:

A. South Texas midshelf relict Pleistocene carbonate reefs bearing turbidity tolerant Antipatharian Zone and Nepheloid Zone (surrounding depths of 60-80 m, crests 56-70 m).

B. North Texas-Louisiana midshelf, Tertiary-outcrop banks bearing clear-water, *Millepora*-Sponge Zone and turbid-water-tolerant Nepheloid Zone (surrounding depths of 50-62 m, crests 18-40 m).

C. North Texas-Louisiana midshelf banks bearing turbidity-tolerant assemblages approximating the Antipatharian Zone (surrounding depths of 65-78 m, crests 52-66 m).

D. North Texas-Louisiana shelf-edge, carbonate banks bearing clear-water coral reefs and Algal-Sponge Zones, transitional assemblages approximating the Antipatharian Zone and Nepheloid Zone (surrounding depths of 84-200 m, crests 15-75 m).

E. Eastern Louisiana shelf-edge, carbonate banks bearing poorly developed elements of the Algal-Sponge Zone, transitional Antipatharian Zone assemblages, and Nepheloid Zone (surrounding depths of 100-110 m, crests 67-73 m).

They categorized similar features containing nepheloid zone communities as Class D banks, where protection is not recommended. Since Sebree Bank is located within a shipping fairway, it is relatively well protected from physical impacts (anchoring or drilling disturbance). While they did not specifically discuss Sebree Bank, based on five ranking criteria, similar nepheloid zone communities were given the lowest rating of all the topographic features.

Big and Small Adam Banks are also low-relief features subject to sedimentation. Rezak and Bright (1981) categorized these features as Class D banks, where protection is not recommended. Although the banks may contain the Antipatharian Zone, this designation is speculative (Rezak *et al*. 1983). Big and Small Adam Banks were given the lowest ratings of those topographic features discussed by Rezak and Bright (1981), based on their criterion for environmental priority rankings.

3.2.2.3 Continental slope

The continental slope is a transitional environment influenced by processes of both the shelf and the abyssal (deep sea) Gulf (>975 m). This transitional character applies to both the pelagic and the benthic realms.

In its entirety, the continental slope of the Gulf basin is a region of gently sloping sea floor that extends from the shelf edge, or roughly the 200 m isobath, to the upper limit of the continental rise, at a depth of about 2,800 m (NMFS no date). The slope occupies more than 500,000 km^2 of prominent escarpments, knolls, basins, ridge and valley topography and submarine channels.

The highest values of surface primary production are found in the upwelling area north of the Yucatan Channel and in the DeSoto Canyon region. In general, the Western Gulf is more productive in the oceanic region than is the Eastern Gulf. It is generally assumed that all the phytoplankton is consumed by the zooplankton, except for brief periods during major plankton blooms. The zooplankton then egests a high percentage of their food intake as feces that sink toward the bottom. Most of the herbivorous zooplankton are copepods, calanoids being the dominant group (Pequegnat 1983).

Compared to the shelf, there is less plankton on the slope and in the deep Gulf. In addition, some of the planktonic species are specifically associated with either the slope or the deep sea. The biomass of plankton does not appear to be affected by seasonal changes. Some east-west variations noted among diatom species have been attributed to the effects of different watermasses, i.e., normal Gulf waters versus those influenced by the Mississippi River (Pequegnat 1983).

Sediment characteristics of the Gulf of Mexico continental slope exhibit regional differences (Gallaway *et al*. 1988). The most common sediment type on the slope was silty clay, occurring in all geographic regions. However, in the eastern Gulf this general sediment type had higher percentages of sand than in the western or central areas of the Gulf. Clay sediments were found in the western and central Gulf but not in the eastern Gulf samples. In contrast, sand-silt-clay sediments were represented at some eastern Gulf stations but absent from the western Gulf stations. Sandy clay was found at shallow and deep stations in the western Gulf and at deep stations in the eastern Gulf.

Gulf of Mexico slope sediments contain a mixture of terrigenous, petroleum, and planktonic hydrocarbons. Petroleum hydrocarbons were detected at all locations and have a dual source in natural seepage and river-associated transport. Hydrocarbons were preferentially associated with clay-like, organic-rich sediments suggesting a linkage with river-derived material. Aromatic hydrocarbon concentrations were very low at all locations but their presence was confirmed by fluorescence analysis.

Megafaunal organisms collected from non-seep areas had variable levels of hydrocarbons in their tissues, mainly derived from the sediments either directly or from organisms that had ingested sediments. Hydrocarbons were more prevalent in fishes than in decapod crustaceans. Terrigeneous hydrocarbons were common but the majority of the hydrocarbons appeared of plankton origin. The central Gulf had the highest levels of total organic carbon and petroleum hydrocarbons and the lowest levels of sand in the sediments, the eastern Gulf had the lowest levels of organic carbon and hydrocarbons in slope sediments and the highest levels of sand, and the western Gulf slope transect was intermediate between these extremes.

The macrofauna (those organisms collected with box corers and retained on a 0.300 mm sieve) of the continental slope of the Gulf of Mexico are abundant (average transect densities ranged from 1,500 to 3,000 individuals/m2) and highly diverse (Gallaway *et al*. 1988). Except in the region of the shelf break, there is little or no tendency towards dominance by any species. A total of 324 individual benthic samples taken in the program contained nearly 50,000 macrofaunal organisms. The concept that the slope macrofauna of the Gulf of Mexico is depauperate is clearly in error. The macrofauna, in fact, consists largely of "rare species." However, the Gulf of Mexico slope macrofauna are neither as abundant nor as diverse as the macrofauna of the U.S. Atlantic slope. Given that both diversity and density levels are reduced Galloway *et al.*(1988) suggested that food limitation is a more likely explanation for the observed differences than a low standing stock due to higher turnover rates in the Gulf.

Most species exhibited highly restricted depth distributions, with variation across isobaths being much greater than variation along isobaths. Sampling depths ranged from approximately 350 to approximately 3,000 m. Gallaway *et al*. (1988) identified three macrofaunal zones on the continental slope of the Gulf of Mexico, one subdivided:

1) Shelf/Slope Transition Zone (150-450 m) is a very productive part of the benthic environment. Demersal fish are dominant, many reaching their maximum populations in this zone. Asteroids, gastropods, and polychaetes are common.

2) Upper Archibenthal Zone: The Archibenthal Zone has two subzones. The Horizon A Assemblage is located between 475 and 750 m. Although less abundant, the demersal fish are a major constituent of the fauna, as are gastropods and polychaetes. Sea cucumbers are more numerous. The Horizon B Assemblage, located at 775-950 m, represents a major change in the number of species of demersal fish, asteroids, and echinoids, which reach maximum populations here. Gastropods and polychaetes are still numerous.

3) The Upper Abyssal Zone is located between 975 and 2,250 m. Although the number of species of demersal fish drops, the number that reach maximum populations dramatically increases. This indicates a group uniquely adapted to the environment. Sea cucumbers exhibit a major increase, and gastropods and sponges reach their highest species numbers here.

4) The Mesoabyssal Zone, Horizon C (2,275-2,700 m) exhibits a sharp faunal break. The number of species reaching maximum populations in the zone drops dramatically for all taxonomic groups.

5) The Mesoabyssal Zone, Horizon D Assemblage (2,725-3,200 m) coincides with the lower part of the steep continental slope in the Western Gulf. Since the Central Gulf is dominated at these depths by the Mississippi Trough and Mississippi Fan, the separation of Horizon C and D assemblages is not as distinct in the Central Gulf. The assemblages differ in species constitution.

6) The Lower Abyssal Zone (3,225-3,850 m) is the deepest of the assemblages. Megafauna is depauperate. The zone contains an assemblage of benthic species not found elsewhere.

The megafauna (caught with trawl) contained over 5,400 vertebrates (fish) and more than 40,600 invertebrates. Some 126 species of fish and 432 species of invertebrates were collected. A complete listing of all taxa by cruise and-station is provided in Gallaway *et al*. (1988). The topographic and physical oceanographic conditions at East Breaks in the Western Gulf support nutrient-rich upwelling, which may significantly contribute to recreational billfishing in the area (as reported by the NMFS) as well as the year-round presence of large pelagic filter feeders such as whale sharks and manta rays (observations from East Breaks production platforms 110 and 165). Both fish and invertebrates showed strong species dominance patterns--i.e. the overall patterns usually reflected the distribution of one or two abundant species (Galloway *et al*. 1988). Only 22 of the 126 species of fish exhibited a total abundance of more than one percent of the catch (>54 specimens) and only 14 of the 432 species of megafaunal invertebrates were represented by as many as 400 specimens (one percent of the total). These data were not adequate to determine trends among regions, seasons, years and depths. For the most part, a few large trawl catches comprise most of the data for each of the abundant species.

3.2.2.4 Vents

Chemosynthetic communities utilize a carbon source independent of photosynthesis that supports all other life on earth. Although the process of chemosynthesis is entirely microbial, chemosynthetic bacteria and their production can support thriving assemblages of higher organisms through symbiosis. The principal organisms include tube worms, clams, and mussels that derive their entire food supply from symbiotic chemosynthetic bacteria, which obtain their energy needs from chemical compounds in the venting fluids. Chemosynthetic communities were first discovered in the Eastern Gulf of Mexico in 1983 at the bottom of the Florida Escarpment in areas of “cold” brine seepage (Paull *et al*. 1984). The fauna here was found to be generally similar to vent communities including tube worms, mussels, and vesicomyid clams.

MacDonald *et al*. (1990) has described four general community types. These are communities dominated by Vestimentiferan tubeworms (*Lamellibrachia c.f. barhami* and *Escarpia* n.sp.), mytilid mussels, vesicomyid clams (*Vesicomya cordata* and *Calyptogena ponderosa*), and infaunal lucinid or thyasirid clams (*Lucinoma* sp. or *Thyasira* sp.). These faunal groups tend to display distinctive characteristics in terms of how they aggregate, the size of aggregations, the geological and chemical properties of the habitats in which they occur and, to some degree, the heterotrophic fauna that occur with them. Many of the species found at these cold seep communities in the Gulf are new to science and remain undescribed. As an example, at least six different species of seep mussels have been collected but none is yet described.

Individual lamellibranchid tube worms, the longer of two taxa found at seeps (the other is an *Escarpia*-like species but probably a new genus) can reach lengths of 3 m and live hundreds of years (Fisher *et al*. 1997). Growth rates determined from recovered marked tube worms have been variable, ranging from no growth of 13 individuals measured one year to a maximum growth of 20 mm per year in a *Lamellibrachia* individual. Average growth rate was 2.5 mm/yr. for the *Escarpia*-like species and 7.1 mm/yr. for lamellibrachids. These are slower growth rates than those of their hydrothermal vent relatives, but *Lamellibrachia* individuals can reach lengths 2-3 times that of the largest known hydrothermal vent species. Individuals of *Lamellibrachia* sp. in excess of 3 m have been collected on several occasions, representing probable ages in excess of 400 years (Fisher 1995). Vestimentiferan tubeworm spawning is not seasonal and recruitment is episodic.

Growth rates for methanotrophic mussels at cold seep sites have recently been reported (Fisher 1995). General growth rates were found to be relatively high. Adult mussel growth rates were similar to mussels from a littoral environment at similar temperatures. Fisher also found that juvenile mussels at hydrocarbon seeps initially grow rapidly, but the growth rate drops markedly in adults; they grow to reproductive size very quickly. Both individuals and communities appear to be very long lived. These methane-dependent mussels have strict chemical requirements that tie them to areas of the most active seepage in the Gulf of Mexico. As a result of their rapid growth rates, mussel recolonization of a disturbed seep site could occur relatively rapidly. There is some early evidence that mussels also have some requirement of a hard substrate and could increase in numbers if suitable substrate is increased on the seafloor (Fisher 1995). Unlike mussel beds, chemosynthetic clam beds may persist as a visual surface phenomenon for an extended period without input of new living individuals because of low dissolution rates and low sedimentation rates. Most clam beds investigated by Powell and Warren (1995) were inactive. Living individuals were rarely encountered. Powell reported that over a 50-year timespan, local extinctions and recolonization should be gradual and exceedingly rare.

Extensive mats of free-living bacteria are also evident at hydrocarbon seep sites. These bacteria may compete with the major fauna for sulfide and methane energy sources and may also contribute substantially to overall production (MacDonald 1998). The white, nonpigmented mats were found to be an autotrophic sulfur bacteria *Beggiatoa* species, and the orange mats possessed an unidentified nonchemosynthetic metabolism (MacDonald 1998).

There is no information regarding reef fish association with chemosynthetic communities.

3.2.2.5 Pelagic *Sargassum* community

The pelagic *Sargassum* community is found worldwide in circumtropical locations (Dooley 1972), and can be found in both nearshore and offshore waters. The pelagic brown algae *Sargassum* spp. provides a dynamic structural habitat in the surface waters of the Gulf of Mexico. The pelagic species propagate by vegetative fragmentation (SAFMC 1998). The plants exhibit a complex branching that forms lush foliage. While most *Sargassum* occurs in the Atlantic Ocean, it also occurs in the Gulf of Mexico. Pelagic *Sargassum* supports a diverse assemblage of marine organisms. Juvenile and adult fish often associated with *Sargassum* also frequent other drifting objects. Possible reasons for the association with *Sargassum* include protection, feeding, cleaning, shade, structural affinity, visual reference, tactile stimulation, historical accident, passive drift, and use as a spawning habitat (SAFMC 1998).

Sargassum acts as a vehicle for dispersal of some of its inhabitants and may be important in the life histories of many species of pelagic, littoral, and benthic fish, providing them with a substratum, protection against predation, and concentration of food in the open Gulf (Dooley 1972). The jacks (carangids) were one of the most numerous and diverse groups associated with *Sargassum*. Very young jacks (< 20 mm) were found within the protection of the weed, while the larger jacks were found progressively further below and away from the weed (Dooley 1972). Large amberjacks, *Seriola dumerili*, dolphin, *Coryphaena hippurus*, and almaco jacks, *S. rivoliana*, are major predators of the *Sargassum* complex. The gray triggerfish, *Balistes capriscus*, is also associated with *Sargassum* (Dooley 1972).

Three species of the brown algae, *Sargassum natans* (80%) *S. fluitans* (10%) and detached sessile *S. filapendula* (10%), comprise the pelagic complex in the Gulf of Mexico (Dooley 1972, Coston-Clements *et al*. 1991). This complex consists of the floating algae and a diverse community of epibiota including algae, fungi, at least 100 species of attached, sessile or motile invertebrates, more than 100 species of fishes and 4 species of sea turtles (Dooley 1972, Coston-Clements *et al*. 1991, Calder 1995). Major groups of invertebrates include hydroids, anthozoans, flatworms, bryozoans, polychaetes, gastropods, nudibranchs, bivalves, cephalopods, pycnogonids, isopods, amphipods, copepods, decapod crustaceans, insects, and tunicates (Dooley 1972). Shrimp and crabs constitute the majority of the invertebrate biomass associated with the *Sargassum* complex and comprise the major source of food for *Sargassum*-associated fish. Nearly 10% of *Sargassum*-associated invertebrates and two species of fish are endemics.

The *Sargassum* found in the Gulf of Mexico is carried there from the North Atlantic via the North Atlantic Gyre then through the Straits of Florida on the Florida Current (Dooley 1972). Once inside the Gulf of Mexico, it either remains drifting in the Gulf Stream, sinks, or is blown ashore by onshore winds. The *Sargassum* complex constitutes a concentration of productivity in the otherwise nutrient-poor epipelagic. If it sinks, it adds organic carbon to deep bottom sediments and constitutes a major nutrient source for deep-sea benthos (Schoener and Rowe 1970). If it drifts, it provides habitat and food resources that would not otherwise be present to a variety of organisms. If it is blown ashore, it provides a source of organic material to beaches and other coastal habitats.

The study by Dooley (1972) presents a list of fishes associated with the *Sargassum* complex in the area of southern Florida where it is picked up by the Florida Current and carried into the Gulf of Mexico. From April 1966-May1967, he collected 3.9 metric tons of floating *Sargassum* from the Florida Current that contained about 8,400 fishes from 8 orders, 23 families, 36 genera and 54 species. Carangidae (jackfish; 14 species), Monacanthidae (filefish; 10 species), Balistidae (triggerfish; 4 species) and Antennariidae (frogfish; 1 species) comprised 90% of all species collected. Of the species managed by the Gulf Council, lesser amberjack (*Seriola fasciata*) and banded rudderfish (*S. zonata*) were listed as moderately-associated with *Sargassum* and gray triggerfish (*Balistes capriscus*), greater amberjack (*S. dumerili*), and almaco jack (*S. rivioliana*) as closely-associated with *Sargassum*.

A recent study of the fish communities associated with *Sargassum* in the northern Gulf of Mexico collected fishes representing 57 families, and 135 species during 2001-2002 (Franks *et al*. 2002). The most numerically abundant fishes were Exocoetidae (28%), Carangidae (27%), and Balistidae (12%). Managed species using *Sargassum* habitat included greater and lesser amberjacks, almaco jack, banded rudderfish, cobia, Spanish mackerel, king mackerel, and gray triggerfish. Potential prey fishes such as the round scad also use *Sargassum*. Pelagic *Sargassum* habitats were found to function as a refuge from predators, a source of prey (such as small shrimp and crabs) for juvenile fishes, spawning substrate for some fishes, and a habitat providing shade and a visual reference.

Many species of jacks are thought to be pelagic spawners and the young use *Sargassum* as a nursery (Bohlke and Chaplin 1968). Very young jacks (>20 mm) were found within the *Sargassum* complex and moved farther below and away from the floating mats as they grew (Dooley 1972). Young amberjacks appeared to use *Sargassum* as refuge whereas large amberjacks were major predators within the complex. Its resident planktonic population of copepods and larval decapods provided food for the juvenile jacks, filefishes and triggerfishes that hid within the protective mat. Larger jacks that swim around and below the mat capture smaller fish and shrimp. The filefishes fed mainly on hydroids and bryozoans, and triggerfishes ate a number of other *Sargassum* invertebrates. The stomach contents of the small gray triggerfish associated with the *Sargassum* complex indicated its heavy reliance on the complex for food. Both filefishes and triggerfishes are important forage fish used by pelagic predators, particularly dolphins and tunas.

It is unlikely that pollution or other anthropogenic impacts could reduce either the extent or productivity of the *Sargassum* complex. However, loss of either extent or productivity could result in impacts to a number of the species managed by the Gulf Council.

3.2.2.6 Currents

In the Loop Current, current speeds may exceed 2 m/s and transports are of the order of 0.03 km^3/s (NMFS no date). Large unstable rings of water are shed off of the Loop Current, bringing massive amounts of heat, salt and water across the Gulf. It is suggested that about 10% of inflowing Loop Current waters are exchanged with the open Gulf (Maul 1978), and the shelf-break region of the Mississippi-Alabama Shelf is influenced by the Loop Current 40% of the time (Kelly 1991). Thus, the Loop Current plays an important role in shelf nutrient balance, at least in the eastern Gulf.

The Loop Current sheds eddies in the northeast Gulf of Mexico as current meanders break off the main current (TAMU 1998). Clockwise-spinning – or anticyclonic – eddies cause warm water to flow towards the center of the eddy and sink to greater depth. The low nutrient water makes cyclonic eddies a marine desert. The anticyclonic eddies also spin off counterclockwise – cyclonic – eddies. Cyclonic eddies flow up from the depths and bring nutrient rich water that supports marine life.

Part of the Loop Current bends to the east after entering the Gulf through the Yucatan Channel and becomes the Florida Current, after leaving the Gulf through the Straits of Florida (TAMU 1998). Some water flows farther north into the Gulf and then veers to the east to form a clockwise gyre bounded by two or more smaller counterclockwise gyres off West Florida. Some water also turns to the west and contributes to a series of anticyclonic warm eddies which travel west across the Gulf in a process of decay that typically last 4 to 10 months. The Loop Current has an annual cycle of growth and decay, but the variability in patterns from year to year is significant.

When the Loop Current is north of 27° N latitude, a large anticyclonic eddy about 300 km in diameter usually separates. These warm core eddies originate as pinched off northward penetrations of Loop Current meanders. In the following months the eddy migrates westward at about 4 km/day until it reaches the western Gulf shelf where it slowly disintegrates over a span of months. The boundary of the Loop Current and its associated eddies is a dynamic zone with meanders, strong convergences and divergences, that can concentrate planktonic organisms including fish eggs and larvae.

Richards *et al*. (1993) collected larvae of 100 different fish families and found that two groups were present in Loop Current boundaries. These were oceanic and continental shelf groups. Within the oceanic group were two subgroups formed by typically mesopelagic families such as the marine hatchetfishes, (sternoptychids), and by ocean but epipelagic families such as the man-of-war fishes (nomeids) and lanternbellies (acropomatids). The shelf group was also divided into two subgroups roughly characterized as the demersals (flounders (bothids), lizardfishes (synodontids), and sea basses (serranids)) plus likely epipelagics (leatherjackets (balistids) and herrings (clupeids)), and the epipelagics (jacks (carangids) and mackerels (scombrids)) along with widely dispersing reef species (wrasses (labrids), parrotfishes (scarids), and scorpionfishes (scorpaenids)). Current boundaries and fronts can concentrate zooplankton and larval fish and are an important habitat for a highly diverse assemblage of fish species (Richards *et al*. 1993).

The productivity associated with the Mississippi/Atchafalaya River system benefits the many fish species that use the northern Gulf as a nursery ground. The same physical and biological phenomena occur in nutrient rich river plumes that extend into the Gulf. The abundance of larval fish around the Mississippi River plume has been well studied (Grimes and Finucane 1991; Govini *et al*. 1989). The plume investigated by Grimes and Finucane (1991) was represented by a shallow lens of water with a salinity less than 34 ppt and temperature less than 29° C (84° F) resting atop warmer but more saline (> 34 ppt) shelf water. They encountered three distinct types of water. These included plume water, northern Gulf of Mexico shelf water, and frontal water, a mixture of the two former types. The frontal zone was about 6 to 8 km wide and contained distinctly visible turbidity fronts that were smaller scale (5 to 100 m). They further reported that individual catches of neustonic ichthyoplankton in frontal water were six times higher on average in frontal than in plume waters, the next highest.

Hydrodynamic convergence associated with frontal waters is a local, but powerful, transport mechanism that could aggregate ichthyoplankton. As surface waters converge, driven by horizontal density gradients and additional factors like tide, wind, and river flow, planktonic organisms move with converging water toward the front. Elevated chlorophyll *a* values associated with frontal waters suggest that primary production is also accentuated there. Presumably, high primary production in frontal waters is due to the mixing of nutrient rich, but turbid, plume water (where photosynthesis is light limited) with clear, but nutrient poor, Gulf of Mexico shelf water (where photosynthesis is nutrient limited), creating good phytoplankton growth conditions.

Grimes and Finucane (1991) found anchovies (engraulids), flyingfishes (exocoetids), drums (sciaenids), and mackerels (scombrids) to be among the most frequently caught families in two of the three water masses. Anchovies were especially common at frontal stations representing nearly one-half of all young fish collected. This concentration of anchovies represents an important food resource for young piscivores like king mackerel, *Scomberomorus cavalla*, and Spanish mackerel, *S. maculatus* (Grimes and Finucane 1991).

Another area of increased primary production occurs on the west Florida shelf each spring (Gilbes *et al*. 1996). The chlorophyll plume occurs mainly during spring with high pigment concentrations persisting for one to six weeks. The plume extends along 250 km of the west Florida shelf from Cape San Blas toward the Florida Keys along the shelf break (Gilbes *et al*. 1996). The cause of the chlorophyll plume is undetermined, but Gilbes *et al*. (1996) suggest that formation may be associated with one or a combination of the following processes. The first is from the discharge of nutrients from small local rivers along the northwest Florida coast. The next possible cause is the circulation of water from deeper Gulf waters to the surface and then southward along the west Florida shelf. This upwelling of nutrients is associated with Loop Current intrusions. The final possible cause is the discharge of the Mississippi and Mobile Rivers. The significance of the yearly spring plankton bloom is that it coincides with reef fish spawning on the west Florida shelf.

3.2.2.7 Manmade structures

3.2.2.7.1 Artificial reefs

Artificial reefs have proliferated in U.S. waters since the 1980s (Seaman 1997), especially in the southeastern U.S. and in the Gulf of Mexico. Yet the role of artificial reefs in the ecosystem has not been resolved. The “creation” of artificial habitat is not necessarily a substitute for conserving valuable, productive or rare habitat that already exists. Fish density and density of lower trophic level organisms are higher on artificial reefs compared to surrounding waters. But do artificial reefs increase production of fish, or merely aggregate them from surrounding areas (Bohnsack 1989; Lindberg 1997)? The answer probably falls within a continuum of variable proportions of aggregation and production, based on an organism’s life history and ecological niche (Bohnsack 1989; Beaver 2002). Factors thought to limit reef fish population size are habitat availability, larval supply and fishery exploitation (Sale 1980). The patchy distribution and limited geographic coverage of reef resources has been suggested as a limiting factor in the abundance of reef fishes (Bohnsack; 1989). Competitive interactions between individuals may dictate reef fish population size because the number of larvae available to settle on reefs far exceeds available space (Sale 1980; Munro and Williams 1985). The fact that there is very limited natural hard-bottom habitat in the northwestern Gulf of Mexico has spurred the development of artificial reef habitats, on the assumption that increasing appropriate habitat will increase populations of hard-bottom, habitat-limited reef fish species (Bortone *et al*. 1997).

The argument for aggregation points out that recruitment limitation is an alternative explanation, and that habitat cannot be limiting for a fish stock in a heavily fished condition (available habitat remains constant as the resource abundance declines).

In most cases, habitat added by artificial reefs accounts for a small part of the total habitat, and would add an insignificant amount to production (Bohnsack *et al*. 1997). However, in the central and western Gulf of Mexico, approximately 4,000 oil-drilling platforms (oil rigs) add considerable structure to a region of typically soft bottom with low relief (MMS 2000). Using Shinn's (1974) estimate of 8,173 m^2 of hard substrate for every 30 m of submerged structure, Beaver (2002) calculated that Gulf platforms represent 3,980 ha of hard substrate in shallow waters (30 m or less) available for colonization by sessile organisms. The majority of this artificial hard-bottom habitat is concentrated in the Gulf's northwest quadrant, off the coasts of Texas and Louisiana. By way of comparison, the Eastern Flower Garden Bank represents 6,700 ha of natural reef habitat, and the Western Flower Garden Bank 13,700 ha of natural reef (Rezak *et al*. 1985).

If artificial reefs do increase production, the effect on fish abundance depends on the relative rates of production and the rates of fishing mortality associated with the artificial reefs (Grossman *et al*. 1997). Grossman *et al*. (1997) found little evidence of regional increases in fish production or of habitat limitation. They cautioned that deleterious effects on reef fish could occur by 1) increasing fishing effort and catch rates; 2) increasing potential for overexploitation by increasing access to otherwise unexploited stock components; and 3) increasing potential for overexploitation by aggregating previously harvested stock components.

Two types of artificial reefs are found in the Gulf of Mexico: structures intentionally placed to serve as habitat for reef-associated species, and structures placed in marine waters to serve another purpose, such as the production of hydrocarbons. Regardless of their intended purpose, once placed, underwater structures are rapidly colonized by diverse assemblages of microorganisms, algae and sessile invertebrates that provide habitat and food for many motile invertebrates and fishes (Reggio 1987; Lindall *et al*. 1998; Dokken *et al.* 2000).

3.2.2.7.2 Oil platforms

While some structures built as part of oil and gas exploration activities provide habitat for invertebrates and fishes in the Gulf of Mexico, there are also negative factors associated with these activities (Dokken *et al.* 2000; MMS 2002a). Whether the positive benefits outweigh the detrimental effects is still a matter of unresolved debate.

Stanley and Wilson (1997) evaluated the abundance and species composition of fish at Gulf of Mexico oil platforms. Use of hydroacoustics in addition to more traditional dive surveys improved the assessment. They found variability in abundance, size composition, and species composition of fish associated with the platforms. Depending on depth, fish density declined to that of ambient areas within 10-50 m of the structure. Six species, with a different mix at each platform studies, made up over 90% of the fish observed. Reef fish in a top-six list included managed species such as almaco jack, amberjack, red snapper, gray snapper (mangrove snapper), and gray triggerfish. Densities ranged from 0.029 fish m^{-3} to 0.496 m^{-3}. Total abundance ranged from about 13,000 to 29,000 fish per platform. Depth and presence or absence of the Mississippi River water influenced densities and abundance.

Species composition data from the various platforms indicate a north-south shift from estuarine to tropical and pelagic dominated communities (Heath *et al*. 2000). Species richness and species diversity were highest off western Louisiana and adjacent to the Mississippi River, and was lowest off central Louisiana. The Flower Garden area off Texas likely serves as a source of recruits for the platform communities of the western side of Louisiana, and live bottom communities off Alabama and Mississippi serve as recruitment sources for eastern Louisiana (Heath *et al*. 2000).

At the end of 1999, 5,862 oil platform installations and 1,879 platform removals left a net of 3,983 platforms in the Gulf of Mexico (MMS 2000) (Figure 3.2.8 and 3.2.9). The MMS requires removal of platforms following termination of a lease, but its policy – the Rig to Reef (RTR) program – encourages reuse of obsolete platforms as artificial reefs. The RTR program has converted 151 platforms to reefs. Three methods of converting platforms to reefs consist of tow and place, topple in place, and partial removal. The first two methods require severing the platform supports at –5 m below mud line. Approximately 64% of the removals used explosives, requiring several hundred pounds per platform (Gitschlag *et al*. 2001).

As a consequence of explosive removals of oil and gas platforms, many fish in the vicinity of the platform are killed. Five species accounted for 90% of the mortality due to explosives (Gitschlag *et al*. 2001): Atlantic spadefish (estimated mean mortality per platform at 1,431), blue runner (541), red snapper (515), sheepshead (455), and gray snapper (122). One of the dominant species associated with platforms, red snapper, is considered overfished and requiring rebuilding (Schirripa 1998a). Gitschlag *et al*. (2001) concluded that even doubling the mortality per platform would have a small impact on the red snapper population, well within the variation of the current assessment, and would not affect management strategy. They recommended no quantitative mitigation measures for platform removals, but suggested minimizing mortality on smaller fish (the most prevalent mortalities).

Wilson and Nieland (in press) examined the role of oil and gas platforms as red snapper habitat in the northern Gulf. They estimated 1.2 to 7.2 million red snapper (mostly 2-4 years old) occupy 2500 platforms in 20-100 m of water in this area.

3.2.2.8 Ecosystem engineers

Many of the organisms discussed in this document may be considered ecosystem engineers. These are species which create more complex habitats 1) via their own morphological structures or 2) through behavioral actions which alter existing habitats (Coleman and Williams 2002). In the first group are species such as corals, mangroves, emergent wetland plants, and seagrasses whose own structure creates complex habitat for fishes and invertebrates (e.g. mineralized reefs, networks of prop roots, or vegetative canopies). Corals are unique among this first group, in that they are both a habitat for many managed species and are managed species themselves. In the second group are a number of Federally managed and non-Federally managed species whose actions physically modify the habitats they occupy. These actions primarily involve excavations of substrate such as those conducted by tilefish to create burrows, but also include the less noticable modifications of bottom habitats by invertebrate infauna (e.g. marine worms, crabs).

The importance of these ecosystem engineers, in terms of the maintenance of community structure, function and diversity has begun to be recognized, as well as the potential consequences to an ecosystem if engineer species are removed by fishing activities (Coleman and Williams 2002). In the Gulf of Mexico, the most obvious examples of ecosystem engineers exploited by fishing activities would be tilefishes and epinepheline groupers (e.g. yellowedge grouper) which inhabit and modify shelf edge and slope biotopes. Their excavation activities produce complex habitats which are utilized by other managed fish (e.g. snowy grouper, vermilion snapper, black grouper) and invertebrate species (e.g. spiny lobster). Burrowing activities also affect biogeochemical cycling and the decomposition of organic matter in the substrate (Coleman and Williams 2002). In addition, because both tilefish and groupers require a relatively long time to reach maturity, they do not recover quickly once they have been overexploited (Coleman and Williams 2002). As they are top-level predators their removal may cause additional problems such as trophic cascades and fishing down the food web (Sala *et al.* 1998, Pauly *et al.* 1998, Steneck 1998). Because of the importance of ecosystem engineers, they may be good candidates to be indicator species of ecosystem health in the future.

3.2.3 Mapping of habitat types

3.2.3.1 Habitat map

The substrate and habitat data in the GIS database was used to generate a master map of bottom habitats (Figure 3.1.3). This map represents the digital representation of the sea-floor habitats described in Sections 3.1, 3.2.1 and 3.2.2. It formed the basis for a substantial amount of the analysis of fish distributions and densities and fishing impacts conducted for this DEIS as described in Section 2.1.

3.2.3.2 Habitat rarity

Section 2.1.4.2.4 describes the calculation of habitat rarity for sea-floor habitats that are depicted in Figure 3.1.3. This calculation is based solely on the polygons in the habitat map. The results of the calculation are shown in Figure 3.2.10. The purpose of this representation of habitat rarity is to identify candidate locations for HAPCs under HAPC Alternative 8 (Section 2.4.5). The results, however, are rather difficult to interpret. This is in part because the analysis is looking across the entire Gulf of Mexico for parcels of habitat that might be only a few miles or less in scale. The total number of individual habitat parcels in the analysis was about 31,500. Of these, about 30,300 (96%) have rarity values that are less than 0.02% of the values of the parcels in the most rare category (Figure 3.2.11).

There are several ways in which this analysis could be enhanced and elaborated given sufficient time and resources (see below). Due to the large number of habitat parcels, each run of the rarity calculation algorithm takes substantial time, even on powerful computers. There was therefore insufficient time before the deadline for the EIS to refine the analysis. It is, however, unclear the extent to which these refinements would alter the outcome in terms of identifying areas for

HAPCs. The results presented here are considered to be sufficiently indicative of habitat rarity to support the identification of candidate areas for HAPCs (see Section 2.4.5).

The main ways in which the analysis could be refined are described below:

- The measurement of habitat rarity is based entirely on the habitat map developed from available information using the GIS, subdivided by habitat zone (estuarine and nearshore/offshore) and eco-region. By their very nature, the rarest habitats are likely to be the least well represented on the habitat map. For example, the large area of hard bottom depicted on the west Florida shelf is in reality a mixture of smaller patches of hard bottom and other substrate types. However, the resolution of the information currently available does not allow a finer scale subdivision of this area. Hence, hard bottom might actually be more rare in this area that is suggested by the map.

- The only features of habitat that were used to characterize them were the habitat type descriptors listed in Section 2.1.3.3.2. Habitat types could be represented on a finer scale if additional descriptors were used (and finer scale information available). If available, such descriptors could include additional layers in the classification system, such as more detailed composition of sediments or finer scale depth divisions. Also, species assemblages could be used as an additional habitat descriptor. All of these suggestions would increase the number of parcels of habitat, and hence reduce the average size. Such an approach would, however, take substantial resources for implementation in the GIS and the likely benefits in terms of identifying HAPCs, over the simplified analysis undertaken to date are not clear.

- The subdivision of the analysis into estuarine and nearshore/offshore areas, while important for representing rarity on a reasonable spatial scale, sometimes creates boundary conditions where a parcel of a habitat type straddles the artificial boundary between one zone and another (note that this problem is likely to be exacerbated by the finer scale division of parcels discussed under the previous bullet). There are a few hundred small parcels that may be affected by this problem in the current analysis, containing habitats such as mangrove and marsh. Some of the mangrove and marsh parcels were placed partly in the nearshore/offshore zone, when they should more realistically be placed in the estuarine zone and not split between the two.

- The nearest-neighbor component of the calculation may have undesirable consequences when there is only one parcel of a certain type within an eco-region (i.e. there is no nearest neighbor). For example, there is only one parcel of clay in the nearshore/offshore zone in eco-region 2. If there were just one other small parcel of clay in this area that was isolated from the existing patch then this would have a significant effect on the calculated rarity of this parcel. This is clearly an effect against which the analysis should be robust.

- The frequency plot (Figure 3.2.11) shows that the distribution of rarity values is extremely skewed (if this were plotted on a linear instead of categorical scale, this would be even more clear). 96% of the parcels have rarity values that are in the lower 0.02% of the range. The statistical properties of this index need to be carefully considered in terms of its utility as a metric for identifying HAPCs on the basis to rarity.

The map of habitat rarity is useful for showing the general results of the analysis on a Gulf-wide basis; however, the most rare habitats are obviously difficult to see. The text table below lists out the habitat parcels that are considered to be most rare according to the analysis. These parcels are plotted on maps and considered as candidates for HAPCs under HAPC Alternative 8 (see Section 2.4.5).

Habitat Parcel	Habitat Type	Habitat Zone	Eco-region	Relative Rarity Index
1	Sand	Estuarine	4. West LA	100 (most rare)
2	Clay	Estuarine	1. S. Florida	51.49438
3	Coral	Nearshore/offshore	4. West LA	16.78988
4	Mangrove	Estuarine	5. Texas	10.46463
5	Oysters	Estuarine	1. S. Florida	5.811977
6	Silt	Estuarine	1. S. Florida	4.304997
7	Hard Bottom	Nearshore/offshore	5. Texas	1.703404
8	Hard Bottom	Nearshore/offshore	4. West LA	1.290693
9	Silt	nearshore/offshore	3. ALMSLA	0.663759
10	Mangrove	Estuarine	4. West LA	0.652734
11	Silt	nearshore/offshore	5. Texas	0.622263
12	Hard Bottom	nearshore/offshore	3. ALMSLA	0.603387
13	Silt	nearshore/offshore	2. N. Florida	0.221341
14	Mangrove	Estuarine	3. ALMSLA	0.141136
15	Silt	nearshore/offshore	1. S. Florida	0.120913
16	Hard Bottom	Estuarine	1. S. Florida	0.107275
17	Marsh	Estuarine	5. Texas	0.076333
18	Sand	Estuarine	5. Texas	0.044627
19	Hard Bottom	nearshore/offshore	2. N. Florida	0.036709
20	Sand	nearshore/offshore	5. Texas	0.030541
21	Oysters	Estuarine	3. ALMSLA	0.021102
22	Coral	nearshore/offshore	1. S. Florida	0.020921

3.2.4 Fishery resources under Federal FMPs

This section provides a series of summaries by fishery management plan of the status of the fish stocks (those for which stock assessment information is available), the species distribution and preferred habitats of managed species and their life stages, and their known prey.

Regarding stock status, one of the most important considerations for stocks that are currently depleted or rebuilding, from the perspective of habitat, is whether the availability of habitat is limiting to their recovery. Several fish species in the Gulf of Mexico are designated as overfished or experiencing overfishing. The current list of these species is as follows:

- Nassau grouper - overfished (assessed pre-SFA, no recent assessment)

- Goliath grouper - overfished (based on anecdotal information, no assessment)
- King mackerel, Gulf group - overfished (assessed pre-SFA, no recent assessment)
- red snapper - overfished, overfishing
- red grouper - overfished, overfishing, but a recent assessment indicates the stock is not overfished and is still subject to overfishing
- greater amberjack - overfished
- red drum - overfished, overfishing
- vermilion snapper – unknown status, overfishing

Several other stocks also appear to be below desirable levels of abundance. Detailed information on the status of assessed stocks is provided in the following sections.

Mace *et al*. (2001) provides a summary of the level of stock assessment information available for each of the managed stocks in the Gulf of Mexico. This summary considered 62 species or species categories in the six FMPs (i.e. not including coral), including all 55 species in the six FMUs. They also considered five types of corals: fire corals, hydrocorals, octocorals, stony corals and black corals.

Forty-seven (47) of the species considered, including all the corals, slipper lobster, little tunny, bluefish and 39 of the reef fish species have no stock assessment, although some data may have been collected and some simple time series plots or tabulations may have been created. Twelve species: red drum, red snapper, vermilion snapper, gag grouper, greater amberjack, king mackerel, Spanish mackerel, cobia, brown pink and white shrimp, and spiny lobster have level 4 (out of 5) stock assessments, which means that one or more of the following is used: size, stage, or age structured models such as cohort analysis and untuned and tuned VPA analyses, age-structured production models, CAGEAN, stock synthesis, size or age-structured Bayesian models, modified DeLury methods, and size or age-based mark-recapture models. Of these only red snapper has assessments updated annually. The others are less frequent, but most have an assessment conducted within the last three years. Cobia has not been assessed for more than 3 years.

Life history information for almost all species comprises only the size composition of harvested fish, which provides a simple index of a stock's growth potential and vulnerability to overharvesting. Basic demographic parameters are available for dolphin and royal red shrimp. Only red drum, red snapper, king mackerel, Spanish mackerel and the three main shrimp species (brown, pink and white) have more information than this, comprising seasonal and spatial patterns of mixing, migration, and variability in life history characteristics, especially growth and maturity, which provides improved understanding of how a population responds to its environment.

Abundance data are available for only 19 of the species considered. Of these, Nassau grouper, Goliath grouper, vermilion snapper, red grouper, dolphin, royal red shrimp, rock shrimp, seabob shrimp[19] and stone crab have a relative abundance index available from fishery catch per unit effort or an imprecise, infrequent survey. Red drum, gag grouper, greater amberjack, king

[19] Rock shrimp and seabob shrimp are not in the shrimp FMU.

mackerel, Spanish mackerel, cobia and brown, pink and white shrimp have data from more precise, frequent surveys with age composition that provide more accurate tracking of changes in stock abundance and recruitment. Red snapper is again the species with the highest level of information available in the Gulf of Mexico (level 3 out of 5), with data available from research surveys with known or estimated catchability, and statistically-designed tagging studies provide estimates of absolute abundance.

The catch data on all species comprises at least a minimum estimate of fishery removals and is typically obtained from mandatory landing receipts. For 52 of the species this is the only catch information. Of the remaining species, red drum, vermilion snapper, gag grouper, red grouper, king mackerel, Spanish mackerel, stone crab, and the three main shrimp species (brown, pink and white) all have spatial data on catch from logbooks can provide information on range extensions and contractions, and other changes in stock or fleet distribution. Greater amberjack, cobia and dolphin have some information on catch size composition. Only red snapper reaches the highest category of catch data availability, which comprises accurate and complete data on total removals (including landed catch, discards, bycatch in other fisheries, and cryptic mortality induced by fishing gear contact) that contributes to accurate stock assessment results.

As described in Chapter 2, maps of species distribution were available from three sources: relative abundance distribution maps downloaded from the NMFS Galveston EFH web page (http://galveston.ssp.nmfs.gov/efh/changes/default_new.htm#Abundance_maps), the 1998 Generic Amendment (GMFMC 1998) and the 1985 NOAA Atlas (NOAA 1985). These maps are not reproduced in this EIS and are readily available for reference purposes in their source documents. Of these sources, only the maps from the 1985 NOAA Atlas were used in the identification of EFH, for reasons explained in Section 2.1.

Descriptions of habitat use by FMP species are based on information from NOAA Life history information tables, Appendix C, Rydene and Kimmel 1995, Hoese and Moore (1977), Robins *et al.* (1986), and Fishbase (www.fishbase.org). There is a lack of information on habitat use for some life history stages, particularly the earliest stages and spawning adults (Table 3.2.35). Some habitats, such as offshore *Halophila* seagrass beds, are also poorly studied with regard to their value as habitat for fishery species. The addition of new information, as it becomes available, might alter the results of the analyses.

The available information was organized in a relational database (the “habitat use” database) created by the contractor specifically for the EIS. The level of habitat use in terms of numbers of species and life stages using specific habitats for specific functions was used as a proxy measure of the relative ecological importance of habitats. Habitat use scores were calculated according to the methodology described in Section 2.1.4.2.1. Tables 3.2.29 through 3.2.34 show the ranking of the habitats according to overall habitat use scores for each of the six FMPs included in the analysis. No analysis was done for coral, as explained in Section 2.1.4.2.1.

Maps showing levels of habitat use by species in each FMP individually and also across FMPs (except coral) are presented in Figures 3.2.12 through 3.2.17. The index for individual FMP maps is based on set intervals within the range of score values, shown as a relative index of 1 to 10 on the maps. The same set intervals were used to construct the relative indexes of all of these maps, in order to make them more comparable to each other. The areas described on the maps as "unknown" habitat use index are either outside the area covered by the analysis, or there was no index value associated with the mapped habitat area.

A cross-FMP composite index for habitat use was also calculated (Tables 3.2.36 and 3.2.37; see Section 2.1.4.2.1 for methodology). This is presented in Figure 3.2.17 using natural breaks in the index, which ranged from 0.09 to 3.98. The habitat use maps for each FMP are described in the following sections, along with a summary of available information on habitat use by individual species and life stages.

The across-FMPs results are rather difficult to interpret. While they were intended to show an overall picture of relative habitat use, there is a remaining problem of the relative influence of the different FMPs. In an attempt to avoid the overwhelming influence of the reef fish on the overall picture, the FMPs received equal weighting in the analysis. However, this may also distort the picture of overall habitat use, given that there are substantial differences in the number of species in the FMPs. Nevertheless, the results are presented here for consideration. The way they should be used in the identification of potential HAPCs should be to identify possible candidate areas that have not been identified by the individual FMP results (which do not suffer from the same weighting problem). We believe it would be risk prone to use these results to indicate that areas shown to have high habitat use in an individual FMP is in fact not important overall.

In eco-region 1, overall habitat use was highest for estuarine SAV, nearshore hard bottoms, nearshore sand/shell, nearshore reefs, offshore pelagic, and nearshore SAV (Table 3.2.37). In eco-region 2, overall habitat use was highest for nearshore sand/shell, offshore pelagic, estuarine SAV, nearshore hard bottoms, nearshore pelagic, and estuarine soft bottoms (Table 3.2.37). In eco-region 3, overall habitat use was highest for nearshore sand/shell, offshore pelagic, estuarine soft bottoms, nearshore pelagic, estuarine sand/shell, and offshore sand/shell (Table 3.2.37). Across FMPs in eco-region 4, overall habitat use was highest for offshore pelagic, nearshore sand/shell, estuarine soft bottoms, nearshore pelagic, estuarine sand/shell, and nearshore soft bottoms. Across FMPs in eco-region 5, overall habitat was highest for offshore pelagic, nearshore sand/shell, estuarine soft bottoms, estuarine sand/shell, nearshore pelagic, and offshore sand/shell (Table 3.2.37).

The habitat use for species in each FMP is described in the Sections 3.2.4.1.2, 3.2.4.2.2, 3.2.4.3.2, 3.2.4.4.2, 3.2.4.5.2, and 3.2.4.6.2, and summarized here. Habitat use for red drum was highest for nearshore hard bottoms, nearshore sand/shell, estuarine SAV, and estuarine soft bottoms. Habitat use for the Reef Fish FMP was highest for nearshore reefs, offshore hard bottoms, offshore reefs in all eco-regions, in offshore pelagic in eco-regions 1, 2, and 5, nearshore SAV in eco-region 1 and 2, offshore sand in eco-region 3, 4, and 5, and offshore shelf edge/slope in eco-regions 3 and 4. Habitat use was highest for the Coastal Migratory Pelagics FMP for nearshore pelagic, offshore pelagic, estuarine pelagic, and offshore drift algae in all eco-regions, nearshore reefs n ecosystem 1, and offshore shelf edge/slope for eco-regions 2-5. Habitat use was highest for the Shrimp FMP for offshore sand/shell and offshore soft bottom for all eco-regions, for nearshore sand/shell for eco-regions 1, 2, 3, and 5, near shore soft bottom for eco-regions for eco-regions 1-5, estuarine soft bottoms for eco-regions 3-5, and nearshore pelagic for eco-region 2. Habitat use for the Stone Crab FMP was highest for estuarine hard bottoms, estuarine sand/shell, estuarine SAV, nearshore hard bottoms, nearshore sand/shell, and nearshore SAV for all eco-regions and estuarine soft bottom in eco-region 2. Habitat use for the Spiny Lobster FMP was highest for offshore reefs, estuarine SAV, nearshore SAV, nearshore hard bottoms, and nearshore reefs in eco-region 1, and offshore pelagic for eco-regions 2-5, where only larvae are present.

Aggregating the highest habitat use for each of the individual FMPs gives a picture different from the cross-FMP composite index for habitat use. Species in the individual FMPs often use habitat different from the species in other FMPs. The aggregate of individual FMP habitat use shows that virtually all of the Gulf of Mexico habitats from the shoreline to the 1000 fathom isobath represent highest habitat use for one or another FMP (Figures 3.2.12-3.2.17).

3.2.4.1 Red Drum FMU

3.2.4.1.1 Status of stocks

During the mid-1980s, directed commercial harvest of red drum in the Gulf of Mexico increased substantially in response to escalating market demands to satiate the growing appetite for "blackened redfish". The Council and the Gulf States Marine Fisheries Commission utilized a state/Federal task force to develop a fishery profile for red drum. The document produced by the task force concluded that red drum were growth overfished in Texas and Florida; however, evidence of recruitment overfishing did not exist. Based on this conclusion, the Council elected not to proceed with an FMP.

The offshore fishery continued to escalate in terms of landings of adult fish, which peaked during the 1985-1986 fishing seasons. In 1986, Congressman John Breaux held a hearing in New Orleans on behalf of the House Subcommittee on Fisheries, Wildlife Conservation and the Environment, to hear testimony on the expanding fishery and the need for future management. Congressman Breaux subsequently introduced H.R. 4690 to require the Secretary to implement emergency regulations to manage the fishery. As a result of the hearing and escalating offshore catches of adult fish, on June 25, 1986, the Secretary promulgated an emergency rule to limit commercial harvest from the EEZ to one million pounds while NOAA Fisheries prepared a fishery management plan (FMP) for the fishery. The FMP was implemented on December 19, 1986, and prohibited directed commercial harvest from the EEZ for 1987. The FMP provided for a recreational bag limit of one fish per person per trip, and an incidental catch allowance for commercial net and shrimp fishermen. Total harvest was estimated at 625,000 pounds; 300,000 by the commercial sector, and 325,000 by the recreational sector. The stock assessment sections of the FMP documented high inshore (state waters) fishing mortality on juvenile and sub-adult red drum and provided analysis that indicated significant long-term risks to the spawning stock biomass (SSB) associated with reduced juvenile recruitment to the adult population and with continued exploitation of adults.

The Gulf of Mexico Fishery Management Council (Council) prepared Amendment 1 to the FMP which was implemented on October 16, 1987. The amendment continued the prohibition of a directed commercial EEZ fishery, but converted the commercial and recreational estimated catch allowances into quotas that were restricted to EEZ waters off Louisiana, Mississippi, and Alabama (the primary area); harvest was prohibited from the EEZ off Florida and Texas (secondary areas). The Council also requested that all Gulf states implement rules within their jurisdictions that would provide for an escapement rate of juvenile fish to the SSB equivalent to 20 percent of those that would have escaped had there been no inshore fishery. Such an escapement rate was judged as necessary to maintain a SSB level that would prevent recruitment failure and collapse of the fishery.

Amendment 2 implemented in 1988 prohibited retention and possession of red drum from the EEZ. This action was based on a Southeast Fisheries Science Center (SEFSC) stock assessment which concluded annual fishing mortality (F) for 1986 on the juvenile population was on the order of 2.0, and consequently escapement rates to the spawning stock biomass (SSB) were likely less than 2.0 percent which would not maintain the SSB at a 20 percent spawning stock biomass per recruit (SSBR) relative to the unfished stock. In addition, fishing mortality on the offshore stock was estimated to be about 0.25 (22 percent annually). The 1987 Stock Assessment Panel report recommended that acceptable biological catch (ABC) be set at zero for the EEZ and that the states increase the escapement rate from the estuaries to 20 percent. The 1989 SEFSC Stock Assessment report indicated the SSBR would likely decline to 13 percent. The 1989 Stock Assessment Panel report recommended ABC for the EEZ be maintained at zero, and that the states increase escapement to 30 percent.

During 1991, the Red Drum Stock Assessment Panel (RDSAP) reviewed stock assessments prepared by NOAA Fisheries, the Louisiana Department of Wildlife and Fisheries, and the State of Florida (Murphy, *et al.* 1990). The RDSAP recommendation was that ABC be set at zero. The Council recommended to NOAA Fisheries that total allowable catch (TAC) be zero for 1992, and that a more comprehensive assessment of a SSBR level be provided in 1992.

The stock assessment for red drum is very uncertain, and the Red Drum Stock Assessment Panel (RDSAP) could not reach a firm conclusion on the Gulf-wide status of the red drum resource (RDSAP 2001). The RDSAP made several assessment runs with a variety of assumptions, and obtained results that ranged from overfished to not overfished (Michael Murphy, FMRI, personal communication). In general, however, most assessment runs showed an overfished condition. In contrast, red drum assessments by the Gulf of Mexico states show that the red drum resource is not overfished (Michael Murphy, FMRI, personal communication).

The uncertainty of stock assessment results largely from inadequate data. Two obstacles are lack of estimates of adult abundance and limited adult age-structure data. The RDSAP concluded that better data on the offshore stock are needed. Red drum are an important resource for both states and the Federal government. States are providing information on red drum in inshore waters and are providing escapement rates. However, the states rely on the Federal government to get the offshore data. Unfortunately, the critical data needed for the assessment are not being collected.

The RDSAP reviewed data available for the stock assessment. Limited amounts of age data occurred from NOAA Fisheries purse seining in 1997-1998. However, the fish used in the study came from only a few schools. Because schools seem to stratify by size, this reduces the power of the data. Randomly sampling a few fish from many schools would improve the data quality. Estimates of instantaneous rates of mortality, annual mortality rate, and annual survival showed a small decrease in mortality for the 1990s compared to the 1980s. Studies examining the reproductive biology of red drum had limited success. Unfortunately no ripe females were captured in the study so batch fecundities could not be estimated. Estimates of spawning frequency indicated spawning occurs about every eight days, although low sample sizes left some uncertainty about this value.

The RDSAP indicated that they did not feel that red drum was a common shrimp bycatch species in state waters, based on their knowledge of state fisheries and what they had found from searching data sets.

The RDSAP examined historical length composition data. Data sets not previously used in NOAA Fisheries' assessments might now be valuable because assessment methods have changed. Most of the red drum length data from landings in the 1980s, summarized in a study from Auburn University, were used in the stock assessment.

The RDSAP discussed development of a standardized stock assessment methodology that can accept area (State) specific data and work with these within the context of a Gulf stock assessment. Two mixing hypotheses were considered. The first is the "overlapping home range" hypothesis where fish may mix freely prior to spawning, but when spawning occurs, fish return to their natal spawning area (high site fidelity) and only spawn with fish spawned in that same area. The second hypothesis is the "diffusion" hypothesis. In this case, if a fish mixes with another population, it stays with that new population and behaves as an individual of that population (including spawning). Genetic studies suggest that some mixing occurs between adjacent populations, but is limited enough to allow for unique genetic differences to be maintained.

An area-specific compartmentalization would make the Gulf-wide assessment more comparable with state assessments. Ecologically, the break points between stocks should be at Galveston and Cape San Blas. This separates the stock into western, northern, and eastern groups. However, political boundaries may make more sense because of state-run data collection programs and different state regulations. Therefore, the break points would be at the Texas-Louisiana and Alabama-Florida borders.

While the data sets and assessment methodology discussed above may improve the assessment, the RDSAP did not feel that these would do much to diminish the uncertainty associated with the assessment results.

Through consensus, the RDSAP recommended that NOAA Fisheries investigate the ideas discussed to improve the assessment, and that adult fish need to be randomly sampled for ages and estimates of adult biomass.

3.2.4.1.2 Habitat use by species in the Red Drum FMU

Red drum are distributed over a geographical range from Massachusetts on the Atlantic coast to Tuxpan, Mexico (Simmons and Breuer 1962). They occur throughout the Gulf of Mexico in a variety of habitats, ranging from depths of about 40 m offshore to very shallow estuarine waters. They commonly occur in virtually all of the Gulf's estuaries where they are found over a variety of substrates including seagrass, sand, mud and oyster reefs. Red drum can tolerate salinities ranging from freshwater to highly saline, but optimum salinities for the various life stages have not been determined. Types of habitat occupied depend upon the life stage of the fish. Information on habitat associations, depth ranges, geographical distribution and other characteristics of different life stages in the Gulf are presented in Tables 3.2.2-3.2.5 and Appendix C. Spawning occurs in deeper water near the mouths of bays and inlets, and on the Gulf side of the barrier islands (Pearson 1929; Simmons and Breuer 1962; Perret *et al*. 1980). The eggs hatch mainly in the Gulf, and larvae are transported into the estuary where the fish mature before moving back to the Gulf (Perret *et al*. 1980; Pattillo *et al*. 1997). Adult red drum use estuaries, but tend to spend more time offshore as they age. Schools of large red drum are common in Gulf waters less than 70 m. A summary of habitat utilization by life history stage is presented in Table 3.2.3.

Estuarine wetlands are especially important to larval, juvenile and subadult red drum. Yokel (1966) concluded that abundance of red drum varied directly with the estuarine area (habitat). He also reported that, in general, landings within a state varied with the amount of that state's suitable habitat. Davis (1980) also discussed red drum occurrence in Everglades National Park, and suggested that recorded changes in species and size distribution resulted from increased salinities from drainage control. An abundance of juvenile red drum has been reported around the perimeter of marshes in estuaries (Perret *et al*. 1980). Young fish were found in quiet, shallow, protected waters with grassy or slightly muddy bottoms (Simmons and Breuer 1962). Shallow bay bottoms or oyster reef substrates were especially preferred by subadult and adult red drum (Miles 1950). Based largely on such observations, the Fish and Wildlife Service (FWS) developed a habitat suitability index model for larval and juvenile red drum (Buckley 1984). The model indicates that shallow water (1.5 to 2.5 m deep) with 50 to 75 percent submerged vegetation growing on mud bottoms and fringed with emergent vegetation provided optimum red drum habitat. The model, however, needs to be further refined, and estuaries in the Gulf need to be surveyed for habitat and optimum environmental conditions available for red drum production.

Levels of habitat use in the Gulf of Mexico by red drum species are mapped in Figures 3.2.12a and 3.2.12b, based on information in the habitat use database. Habitat use was highest for nearshore hard bottoms, nearshore sand/shell, estuarine SAV, and estuarine soft bottoms. These same habitats were the most important in all five eco-regions (Table 3.2.29). This information is used to identify possible candidate sited for HAPCs under the Red Drum FMP (see Section 2.4.5 – HAPC Alternative 8).

3.2.4.1.3 Prey and predators of life stages in the Red Drum FMU

Estuaries are important habitat for the prey species of red drum (GMFMC 1986). This is especially true for the larvae, juveniles and early adults of red drum as they spend virtually all of their time in estuarine habitat. Larval red drum feed almost exclusively on mysids, amphipods, and shrimp, whereas larger juveniles feed more on crabs and fish (Peters and McMichael 1987). Overall, crustaceans (crabs and shrimp) and fishes are most important in the diet of red drum; primary food items are blue crabs, striped mullet, spot, pinfish and pigfish. As they grow larger, red drum eat proportionately more crabs, with fish diminishing in importance as food for the largest red drum (Mercer 1984). Protection of estuaries is especially important not only to maintenance of essential habitat for red drum but also because so many of the prey species of red drum are estuarine dependent (e.g., shrimp, blue crab, striped mullet and pinfish). Documented prey and predators of red drum are listed in the following tables. They are not listed in any particular order. Spot and Atlantic croaker feed on juvenile red drum, while sharks, amberjacks, and other large fishes may feed on adults.

Prey species of various life stages of the red drum ***Sciaenops ocellatus***:

Common Name	Taxa
Copepods	non-specific
Other sciaenids	non-specific
Spot	*Leiostomus xanthurus*
Atlantic croaker	*Micropogonias undulatus*
Caridean shrimp	*Palaemonetes pugio*
Gulf menhaden	*Brevoortia patronus*
Juvenile crabs	*Callinectes* spp.
Striped mullet	*Mugil cephalus*
Bay anchovy	*Anchoa mitichilli*
Pinfish	*Lagodon rhomboides*
Hardhead catfish	*Arius felis*
Juvenile eels	non-specific
Sea cucumber	*Sclerodactyla briareus*
Five lunuled sand dollars	*Mellita quinquiesperforata*

Common Species that Prey upon the red drum *Sciaenops ocellatus*:

Common Name	Taxa
Spot	*Leiostomus xanthurus*
Atlantic croaker	*Micropogon undulatus*
Amberjacks	*Seriola* spp.
Sharks	Non-specific
Any larger piscivorous fish	Non-specific

3.2.4.2 Reef Fish FMU

3.2.4.2.1 Status of stocks

The Reef Fish Fishery Management Plan applies to 42 species (Table 1.5.1). Of these, seven have had stock assessments performed[20]. Commercial catches are presented in Section 3.3.

Most of the stock assessments used spawning potential ratios (SPR) to determine overfishing and whether the stock is in an overfished condition. However, MRAG Americas (2001) demonstrates that while SPR effectively indexes overfishing (fishing mortality (F) is too high), it does not index the overfished condition (biomass too low). SPR does not track recruitment trends, so biomass can increase or decrease independently of SPR. Thus, the practice of using SPR as a proxy for Maximum Sustainable Yield (MSY) is not appropriate. The extent of stock depletion and appropriate harvest levels should be indexed by absolute or relative estimates of biomass. The Council recognized this problem and through its Generic SFA amendment modified the framework procedure for specifying TAC for all the finfish stocks, to provide for adopting biomass-based overfished thresholds as NMFS and the stock assessment panels develop these parameters.

An economic and social assessment for the reef fish fishery was completed and delivered to the Gulf Council's Socio-Economic Panel in September 2000.

3.2.4.2.1.1 Red snapper

The management of red snapper (*Lutjanus campechanus*) has been surrounded by much controversy over the last decade, in particular because a large number of juvenile fish are caught as bycatch in shrimp trawls. Since the late 1980s, the stock has been considered to be in a severely depleted condition, and in need of rebuilding. This is one of the few species for which transitional SPR has been used as a measure of stock status, relative to target and limit (threshold) measures of static %SPR (e.g. Goodyear 1995; Schirripa 1998a, 1999). However, NOAA Fisheries rejected the use of transitional SPR as a biomass proxy in 2000 (partial approval of the SFA Amendment, 11/17/1999), because under certain conditions, such as a change in habitat, transitional SPR could move independently of stock biomass. In the latest

[20] Red Snapper Stock Assessment _ 1999. Status of the Red Snapper in U.S. Waters of the Gulf of Mexico Updated Through 1998 (Schirripa and Legault, 1999).; Gag Stock Assessment _ 2001. Status of Gag in the Gulf of Mexico Assessment 3.0 (Turner *et al*., 2001); Amberjack Stock Assessment _ 2000. Stock Assessment of Gulf of Mexico Greater Amberjack Using Data Through 1998 (Turner *et al*., 2000); Gray Triggerfish Stock Assessment. A Stock Assessment for Gray Triggerfish, *Balistes capriscus*, in the Gulf of Mexico (Valle *et al*., 2001) and Assessment of Gray Triggerfish, *Balistes capriscus*, in the Gulf of Mexico Using a State-Space Implementation of the Pella-Tomlinson Production Model (Porch, 2001); Vermilion Snapper Stock Assessment. Status of the Vermilion Snapper Fishery in the Gulf of Mexico - Assessment 5.0 (Porch and Cass-Calay, 2001); Red Grouper Stock Assessment. Status of Red Grouper in United States Waters of the Gulf of Mexico During 1986-2001 (Southeast Fisheries Science Center, Sustainable Fisheries Division Contribution No. SFD-01/02-175); Yellowedge Grouper Stock Assessment. Status of the Yellowedge Grouper Fishery in the Gulf of Mexico (Cass-Calay and Balnick, 2002).

version of the red snapper rebuilding plan, the Council proposes the use of direct estimates of stock biomass relative to biomass thresholds and targets.

In recent years, fishers have reported seeing and catching many more and larger fish, and the species appears to be returning to the waters of the eastern Gulf. Yet, the estimate of transitional SPR has remained well below the overfishing limit (threshold) (Schirripa 1999). With several years of strong recruitment, one would expect the catches to improve. However, since newly recruited year classes take some time to contribute significantly to the reproductive potential of the stock, it also takes time before these year classes generate a corresponding increase in transitional SPR. This is particularly true when the spawning stock is composed of a large number of year classes.

Since 1990, the Gulf Council has set targets for recovery of Gulf red snapper based on SPR measures and specified rebuilding times. Monitoring over the period 1993 to 1995 indicated improvements in the stock status, which appeared to indicate that management actions were having a positive effect on the stock. However, simulations conducted by NOAA Fisheries in 1997 indicated that at the constant TAC of 9.12 million pounds, the goal of 20% SPR would not be reached by 2019, even with a reduction of bycatch in shrimp fishery of 44%. The NOAA Fisheries assessment concluded that to reach the goal, either the TAC had to be lowered to 6 million pounds or bycatch needed to be reduced by 55%. Scientists also noted that future levels of SPR were much more sensitive to differences in bycatch mortality than differences in levels of TAC. Unfortunately, the former is much more difficult to achieve. NOAA Fisheries agreed in early 1998 to adopt the Council’s recommendations regarding the use of bycatch reduction devices (BRDs) and agreed to retain the 9.12 million pounds TAC. However, this was subject to scientific verification of a BRD efficiency rate of at least 60%.

In 1999, a new red snapper stock assessment was prepared by the NMFS SEFSC (Schirripa and Legault 1999). In view of new requirements of the M-S Act, associated Technical Guidelines, and the concern stated in the 1997 Peer Review that uncertainty in the stock assessment had not been fully characterized, a new modeling methodology was used for the Red Snapper Stock Assessment. This methodology called the Age-Structured Assessment Program (ASAP) provides greater flexibility in population model structure and provides internally consistent estimates of management parameters of interest (e.g., the instantaneous fishing mortality rate and stock biomass level capable of producing MSY [F_{MSY} and B_{MSY}]). ASAP includes a statistical fitting procedure that provides an improved basis for characterizing uncertainty in the evaluation of a stock’s status.

Results of the ASAP model showed that the condition of the stock was, in general, the same as was reported in the 1995 assessment (Goodyear 1995). The 1995 assessment was the basis for the initial setting of the current 9.12 million pound TAC. Fishing mortality has increased in the recreational sector over time, has remained flat in the commercial handline (west) and shrimp bycatch sectors, and has decreased in the commercial handline (east) and commercial longlines. The estimated abundance of exploitable-sized red snapper has increased rapidly in recent years, although the total population has not increased and may have even slowly decreased.

However, anecdotal information, fishery dependent information, and Alabama tagging data (Shipp 2002) show that red snapper are repopulating in the Florida Shelf (see Goodyear 1995 for previous status of Florida Fishery). Recent otolith microchemistry and aging analysis suggest there are three indentifiable subpopulations of red snapper. One off Texas, one off Louisiana, but the Alabama sub-population is separate and is responsible for repopulating the Florida shelf [(Cowan et al. (2002), Wilson, and Nieland (2002), and Gold et al. (2002)].

A regulatory amendment to the Reef Fish FMP submitted to NOAA Fisheries by the Gulf Council in May 2001 proposed to modify the red snapper rebuilding plan to comprise a 31-year rebuilding schedule with 5-year interim management goals as follows:

- set TAC for years 2001-2005 at 9.12 million pounds;
- assume bycatch reduction at 40% (existing BRD requirements);
- develop technological and management mechanisms to allow for a 60% reduction in bycatch after 5 years and up to an 80% reduction in bycatch after 10 years. (note: recent research by NMFS [Watson 2001] have yielded information on the behavior of red snapper and the water circulation patterns within shrimp trawls that suggest that refinement of BRDs may make these levels of reduction feasible); and
- use the decision-tree process to set TAC at 5-year intervals (beginning with the TAC to be set in 2006) based on the degree of change in stock biomass (B) in relation to BMSY.

The rebuilding targets and thresholds associated with this alternative were as follows:

Maximum Sustainable Yield (MSY)	41-66 million pounds
Optimum Yield (OY)	- 2001-2005; OY=9.12 million pounds; - 2006-until recovery ($B_{current}$ /B_{MSY} < 1), OY is the yield defined by a constant fishing mortality rate strategy consistent with rebuilding to B_{MSY} within the allowable rebuilding period. - After achieving the rebuilding target, OY is the yield corresponding to a fishing mortality rate (F_{OY}) defined as: F_{OY} =0.75*F_{MSY} (The magnitude of this yield depends on the ultimate biomass at MSY and cannot be reliably estimated at this time.)
Maximum Fishing Mortality Threshold (MFMT)	F_{MSY} [the range for F_{MSY} is 0.116-0.092 (33-36% static SPR)]
Minimum Stock Size Threshold (MSST)	Existing estimates of B_{MSY} and MSST are not considered reliable; however, all available scientific information indicates that $B_{current}$ is << (1-M)*B_{MSY}. Based upon maximum recruitment equal to the low recruitment scenarios with steepness of 0.90 or 0.95, the B_{MSY} = 2.6-2.7 billion pounds and MSST [(1-M)*BMSY = 0.9*B_{MSY}] = 2.3-2.4 billion pounds

NOAA Fisheries determined that the modification of the red snapper rebuilding plan warrants the preparation of a draft supplemental environmental impact statement (DSEIS), rather than the environmental assessment that accompanied the Council's regulatory amendment. Thus, the Council is initiating a process to develop a DSEIS to evaluate alternative biomass-based stock rebuilding targets and thresholds for red snapper, and to consider various rebuilding schedules, consistent with the legal mandate provided by Section 304(e)(4) of the Magnuson-Stevens Fishery Conservation and Management Act (M-S Act) to rebuild overfished stocks in as short a time period as possible, taking into account other factors, including the status and biology of the overfished stock and the needs of fishing communities. The DSEIS also considers various alternatives to achieve the rebuilding goal based on a constant catch scenario and/or a constant fishing mortality rate scenario. The Council is soliciting public input on the range of alternatives to be considered in the DSEIS and on the significant issues related to the actions considered.

The SEFSC will deliver an update on the red snapper stock assessment in August 2003, including landings, recruitment indices, CPUE, and bycatch. NOAA Fisheries will examine available options for incorporating variability of shrimp trawl bycatch estimates into the red snapper stock assessment. NOAA Fisheries has been involved in construction of an index time series of abundance based on older red snapper individuals to monitor stock rebuilding, using fishery-independent monitoring. Additional work in progress will provide data for the 2004 red snapper stock assessment. This work includes reconstruction of historical landings to estimate more effectively steepness and maximum recruitment parameters of the spawner-recruit function, evaluation of the mechanisms that underlie the very high value of the steepness parameter for red snapper, and continued red snapper aging work with effort devoted to aging of archived samples.

In preparation for the of the red snapper stock assessment in 2003, the SERO/SEFSC is reorganizing the Fishery Economic Office to include socio-economic research capabilities. A master plan of socio-economic research in support of managed species in the SE Region will lead to an evaluation of the economic value of the commercial catch through support industries and the consumer, rather than just through the ex-vessel price.

3.2.4.2.1.2 Vermilion snapper

Vermilion snapper are caught throughout the Gulf of Mexico, and most landings occur in Florida (Schirripa 1998b). Fishermen who catch vermilion snapper also catch a variety of other species. Florida leads in landings for both commercial and recreational fisheries, while Louisiana has the second highest commercial landings, and Alabama has the second highest recreational landings. Handline fishermen dominate commercial landings, and a small fraction of the fleet (2-3%) catches most of the harvest (50%). About 10 headboats account for 50% of harvest from that mode. Vermilion snapper headboat landings increased regularly from 1981 to 1993, and declined through 1995. Schirripa (1998b) concluded that vermilion snapper were not over-harvested, but recruitment and catch trends point to possible declining future abundance. SPR from 1986-1995 ranged from 0.26-0.28.

Schirripa and Legault (2000) updated the previous stock assessment with data through 1998, with some catch data from 1999. The commercial fishery accounts for 70-80% of fish landed by weight. Commercial landings increased from around 1 million pounds in the early 1980s to a peak near 2.7 million pounds in 1993. Catch declined for three years, and remained in the 2.3-2.6 million pound range from 1996-1998, comparable to landings in the early 1980s. Longline fisheries took a small fraction, mostly in the 1980s. Recreational harvest jumped from 0.1-0.6 million fish in the early 1980s to 1.0-1.5 million fish from 1986 to 1995. Harvest for 1996-1998 dropped to 0.4-0.6 million fish, slightly above harvest of the early 1980s. The headboat fishery accounts for one-third to one-half of the recreational catch, and charter boats account for most of the rest. The recreational fisheries discard about 15 to 25% of their catch. Schirripa and Legault (2000) suggested that vermilion snapper is a bycatch of the red snapper fishery, and Schirripa (1998b) noted that vermilion snapper catch varied inversely with red snapper catch. Declining catch may, therefore, be associated with increasing abundance of red snapper. While CPUE of the commercial vessels has varied without trend since 1990, the recreational headboat CPUE has declined more than 50% since 1993.

Schirripa and Legault (2000) assessed stock condition using two VPA models that added abundance indices to the model used in 1998. Both models used a recruitment index from the NOAA Fisheries Fall Groundfish Survey. One model incorporated CPUE from both the handline and the headboat fisheries, while the other did not use the handline CPUE. The handline-headboat CPUE represents data from virtually the entire fishery, while the headboat-only CPUE incorporates data from about 10% of the landings. The handline-headboat model indicated a high probability of overfishing and the overfished condition, while the headboat-only model indicated a low probability of overfishing and the overfished condition.

The most recent assessment of the vermilion snapper fishery was undertaken in 2001 using data through 1999, with some commercial catch data for 2000 (Porch and Cass-Calay 2001). Two models were used: VPA and a non-equilibrium production model. The majority of the six VPA runs and the production model runs that used the full time series of data indicate that the stock is overfished and is undergoing overfishing. These results were considered to be consistent with the results of Schirripa and Legault (2000). Two of the VPA runs and one of the production model runs (one that did not use the last three years of data) indicated that the stock is not overfished and that no reduction in the current rate of fishing is required. Of the model runs that indicated the stock was overfished, the VPAs indicated the need for a reduction in the rate of fishing by one to two thirds. The production models indicated that the fishing mortality needs to be reduced to about half its current level. One of the main problems cited in the assessment was conflicting trends in time series of catch per unit effort. The commercial CPUE series suggests there has been little change in the relative abundance of vermilion snapper, but the eastern headboat index suggests that they have declined dramatically. Due to the uncertainty in the assessment results, confidence regarding conclusions about whether vermilion snapper are actually overfished are low.

In summary, NOAA Fisheries has not declared vermilion snapper overfished, but that they are undergoing overfishing. However, the RFSAP concluded that the vermilion snapper stock may now be overfished and that overfishing will continue at the current rates of fishing. Some reduction is therefore necessary. The RFSAP and NOAA Fisheries biologists determined that a production model was preferable to assess this species because it avoids using catch at age data. Studies have shown that growth is highly variable for vermilion snapper making it difficult to predict age from length. Unfortunately, production models require a long time-series of catch data that are not available for vermilion snapper, and so consequently the production model run on this species is highly uncertain.

3.2.4.2.1.3 Red grouper

Red grouper are caught mostly in the Gulf of Mexico from Panama City, Florida to the Florida Keys, and primarily south of Tampa. Red grouper catch statistics were no longer lumped with other grouper species in 1986 (Goodyear and Schirripa 1993). Cuban fishermen caught a significant amount of red grouper from U.S. waters prior to extended jurisdiction in 1976. Handline/power reel fishermen caught most of the red grouper until the early 1980s when longlines increased operations and dominated the catch. Florida implemented an 18-in minimum size limit in 1985 for state waters and the Council implemented a 20-in minimum size limit in 1990 for the EEZ, which Florida matched in state waters. Goodyear and Schirripa (1993) concluded that red grouper were not overfished through the early 1990s. They estimated SPR at around 30%.

Schirripa *et al*. (1999) updated the previous assessment with data through 1997. By applying the ratio of red grouper to all grouper from 1986-1997 to the total US grouper catch and incorporating the Cuban red grouper catch, Schirripa *et al*. (1999) estimated the historical catch. Total catch, including Cuban, U.S. commercial and recreational, peaked during the late 1940s to 1950s at 14 to 18 million pounds. A substantial drop in Cuban catch led to a total catch around the 8-10 million pound range from the 1960s until the exclusion of the Cuban fleet in 1977. Subsequently, the U.S. catch fluctuated from 6-11 million pounds. Since 1986, the commercial handline catch of red grouper declined by about half, while the longline catch showed no trend. Trap fisheries represented a minor component. The recreational fishery peaked in the mid- to late-1980s at about 0.6-1.0 million fish retained per year. Catch dropped to 0.2 million fish in 1990 following the minimum size limit, increased somewhat in 1992-1993, and declined to 0.2-0.1 in 1996-1997. Since 1983, recreational fishermen have released most red grouper, up to 80 to 90 % in the 1990s.

Commercial CPUE values, estimated from logbook data, for the longline, handline, and trap fisheries remained fairly constant from 1990 when logbook coverage began (Schirripa *et al*. 1999). Recreational CPUE (retained plus discarded) showed different patterns from the Harvest Per Unit Effort (HPUE) (retained only). HPUE for private/charter boats and for headboats declined from the mid- to late-1980s to reach minimum historical values in 1996 and 1997. Private/charter HPUE dropped following the minimum size limit of 1985 (no data available for headboats) and dropped minimally in 1990. Headboats HPUE dropped about 50% in 1990. Private/charter CPUE increased in 1990 indicating increased catch of discarded fish. Later declines in CPUE paralleled HPUE. Schirripa *et al*. (1999) suggested that the CPUE could index undersized red grouper, and the recent decline could portend declining recruitment. However, the parallel CPUE-HPUE pattern could also suggest a declining legal component, but not necessarily declining sublegal component.

Use of a stock production model (ASPIC) and a virtual population analysis (ASAP) both demonstrated an overfished condition and overfishing occurring (Schirripa *et al*. 1999). Using ASPIC, the estimated biomass relative to biomass at MSY (B_{msy}) declined rapidly from the 1940s to 1960, then declined gradually to current levels less than half B_{msy}. Over the same time period, estimated fishing mortality increased to over twice the fishing mortality at MSR (F_{msy}). $B/B_{msy} < 0.8$ and $F/F_{msy} > 1.0$ indicate an overfished condition and overfishing occurring for red grouper. Estimates from a series of ASAP models with different assumptions showed B_{msy} ranging from 0.19 to 0.60 and F/F_{msy} ranging from 1.4 to 3.2.

The Reef Fish Stock Assessment Panel (RFSAP 1999), reviewing Schirripa *et al*. (1999), chose the ASAP model with the full time series as most representative of the stock status, but noted that the similarities of the ASAP and ASPIC model results increase confidence in the ASAP model. The RFSAP (1999) recommended a recovery time of F = 0 plus one generation (2018 target date). Subsequently, the RFSAP (2000) reevaluated the red grouper stock assessment, especially suitability of the Cuban data, and requested additional runs of the ASAP model to explore other assumptions. The Panel selected the data since 1986 (no Cuban data) as most representative and that overfishing and the overfished condition were not as great as with the longer data set. The Panel recommended a 10-year rebuilding period. The SEFSC conducted an assessment in 2001 and Secretarial Amendment 1 to the Reef Fish Fishery Management Plan which set a 10-Year Rebuilding Plan for Red Grouper, with Associated Impacts on Gag and other Groupers, was submitted to NOAA Fisheries in October 2002 for Secretarial review.

In January 2003, the Council reviewed the latest red grouper stock assessment (NMFS 2002c) and recommendations of the Reef Fish Stock Assessment Panel, Socioeconomic Panel, Reef Fish SSC and Reef Fish AP. The red grouper stock was in an improved condition compared to 1997, but it was not yet at a biomass level that would allow maximum sustainable yield (B_{MSY}). New biological information on stock fecundity in the 2002 assessment resulted in a higher estimate of the 1997 biomass compared to the estimate made in the previous (1999) assessment, but the spawning stock biomass in 1997 was still estimated to be in an overfished state at that time. The 1997 stock status, when using a spawner-recruit curve steepness parameter of 0.7 as recommended by the Reef Fish Stock Assessment Panel, was at 62% of B_{MSY}, well below the 80% threshold for declaring the red grouper stock to be overfished. As of 2001, the spawning stock biomass had improved to 84% of B_{MSY}, thanks in part to a strong year-class in 1996. Although the stock is now above the overfished threshold, the requirement to rebuild to 100% of B_{MSY} by 2012 remains. However, less restrictive measures are needed than previously proposed, and only about a 10% harvest reduction is needed rather than the 45% previously sought. Since the red grouper rebuilding plan is a Secretarial amendment rather than a Council amendment, a final decision on changes to the rebuilding plan will be made by NOAA Fisheries. The Council has made the following recommendations to NOAA Fisheries to modify the rebuilding plan in Reef Fish Secretarial Amendment 1.

> *Adopt a ten-year rebuilding strategy to B_{MSY} based on a constant F strategy, spawner-recruit curve steepness value of 0.7, and a three-year stepwise strategy, resulting in an annual red grouper TAC of 6.55 million pounds gutted weight for the first three years 2003-2005. This will require a red grouper harvest reduction of 2.0% from the 1990-2000 average harvest (6.683 million pounds gutted weight) or 9.6% from the 1999-*

2001 average harvest (7.248 million pounds gutted weight). The TAC for subsequent years will be determined following a stock assessment in 2005.

3.2.4.2.1.4 Gag

Gag are caught on the west coast of Florida from northern Pinellas County to the northern extent of the state (Schirripa and Goodyear 1994). Misidentification of gag and black grouper caused problems in all data sets except for scientific research data. Schirripa and Goodyear (1994) used species composition, obtained by trained staff in MRFSS, and headboat observations from 1990-1992 to correct recreational and commercial catch and landing data. They did not use information from commercial logbooks because some fishermen non-quantifiably changed reporting from black grouper to gag and because of large discrepancies between MRFSS-headboat and commercial logbook data. After re-apportioning gag-black grouper catches based on scientific data collections and observed recreational catch, Schirripa and Goodyear (1994) concluded that gag were not overfished, although the male to female ratio had decreased from the late 1970s to the early 1990s. They estimated SPR at approximately 30%.

Schirripa and Legault (1997) most recently updated the previous assessment with data through 1996, used preliminary estimates of discard mortality rates of sublegal-sized gag, and evaluated the implications of protogynous hermaphroditism in the stock assessment. For 1986-1996, years with gag harvest separated from other groupers, the commercial catch remained fairly constant in the range of 1.5 million pounds. The commercial harvest does not show an effect of a 20-inch minimum size limit set in 1990. Applying the average ratio of gag to other groupers (1986-1996) to catches from 1965 suggested lower commercial gag harvest of around 1.0 million pounds through the 1980s. The recreational fishery showed the effects of a minimum size limit with lower catch since 1990. The recreational fishery showed an order of magnitude increase in discarded gag since 1990.

CPUE for commercial (handline, bottom longline, and trap) and recreational (headboat and private) fisheries, though variable, also remained fairly stable during the 1986-1996 period (Schirripa and Legault 1997). Recreational fisheries harvest smaller fish than do the commercial fisheries. The average size of gag in the commercial and recreational fisheries showed no trend during the 1986-1996 period, although the average size increased following implementation of a minimum size in 1990. Harvest, CPUE, and mean size indices suggest that the fishery for gag has not changed much since 1986.

Fishing mortality estimated with catch curve analysis and with several VPA models indicated recent $F > F_{0.1}$ or F_{max}, generally by a factor of two or more. F values estimated with VPA that incorporated variable recruitment were higher than estimates with constant recruitment, but the estimates from variable-recruitment were judged unreasonable. About 25% of the estimated F came from estimated mortality of discarded gag.

SPR values ranged widely depending on estimation of F in the VPA models and on assumptions about fecundity. The fecundity function had the most effect on SPR. The RFSAP (1998) judged that the transitional SPR from the most reasonable assumptions were slightly above the

Council's current threshold of 20%. Schirripa and Legault (1997) noted that protogynous hermaphrodites such as gag do not fit the assumptions for SPR, and that SPR may not apply well to gag. They recommended maintaining SPR well above the 20% threshold as a cautionary measure. However, the shift from female to male is equivalent of a higher natural mortality for females, which would underestimate actual SPR, and provide more conservative management (MRAG Americas 2001). Even so, SPR does not adequately reflect the condition of stock biomass.

Schirripa and Legault (1997) and the RFSAP (1998) expressed concern that spawning aggregations of gag may be more vulnerable to harvest than suggested by the standard models and reference points. This concern is reflected in the spawning ground closures implemented by the Council.

In the most recent stock assessment, information on landings and discards, size composition, size at age, and catch rate information from multiple recreational and commercial fisheries were used to develop the catch history and the catch-at-size for the stock from 1986 through 1999 (Turner *et al*. 2001). This assessment was reviewed by the Council's RFSAP. The RFSAP believed that the most reliable characterization of the stock status was derived from use of an age-based assessment, incorporating the fishery-based abundance indices. Variability in the assessment about the current condition of the stock was high, but most of the estimates of the $SSB_{current}$ were above $SSB_{30\% SPR}$, and estimates of $F_{current}$ were below $F_{30\% SPR}$. The dispersion of points about F_{MAX} (a proxy considered for the maximum fishing mortality threshold, MFMT) and SSB_{MAX} were closer to the current condition of the stock. About 59% of the estimates of $F_{current}$ are below F_{MAX} (indicating a 41% chance that overfishing was occurring). Most (85%) of the point estimates indicated $SSB_{current}$ was above the minimum stock size threshold (MSST) of 85% of SSB_{MAX} (default control rule for M=0.15), indicating that there was only about a 15% chance that gag was overfished.

3.2.4.2.1.5 Yellowedge grouper

The status of the stock remains essentially undetermined. An age-structured stock assessment model for yellowedge grouper in the U.S. Gulf of Mexico was conducted in 2002 (RFSAP 2002). The model was very sensitive to input parameters, and small changes in highly uncertain parameters resulted large changes in the estimated status of the stock. Therefore, the RFSAP concluded that the analysis of the stock was insufficient to determine the status of the stock relative to the definitions of overfished and overfishing (RFSAP, 2002). However, because of the longevity of yellowedge grouper, they may be particularly susceptible to even relatively low fishing mortality rates. The RFSAP recommended that the commercial yield should not greatly exceed the historical average of 0.84 million lbs. (381 metric tons).

3.2.4.2.1.6 Greater amberjack

Amberjacks in the Gulf of Mexico are caught primarily along the west coast of Florida, westward to about the Mississippi River. Amendment 1 of the Reef Fish Fishery Management Plan concluded that amberjacks were overfished, and that the fishery harvests had increased in the recent years prior to the Amendment. The RFSAP concluded in 1993 that available data were too poor in quality and quantity to use for stock assessment, but that data existed to monitor the trends in the fishery. McClellan and Cummings (1996) cited severe under-sampling of the amberjack fisheries for length and weight data. They updated landing, catch per effort, and biological data, and presented results of a VPA analysis for greater amberjack. Declining biological sampling after 1993 diminished reliability of results after 1994. McClellan and Cummings (1996) concluded that fishing mortality for adult fish (ages 4-7+) during 1987-1995 ranged from 0.10-0.45, with values below 0.15 in 1994 and 1995; that fishing mortality on young fish (ages 1-3) dropped in 1990 after a minimum size limit went into effect. Abundance estimates were variable, with increases in 1993-1995. They found an SPR of 0.43 in 1994.

The most recent stock assessment was presented to the RFSAP in August 2000. This stock assessment used a calibrated VPA to obtain estimates of population abundance and mortality rates using data through 1998. A variety of runs indicated that the greater amberjack stock was overfished in 1998 based on the MSST (GMFMC 2002). The best estimate of stock size (i.e., using the median value) in 2000 showed that the stock is at less than one-half of MSST (using the default control rule). Although some of the combinations indicated that overfishing was occurring [projected for 2000 as 14% above $F_{30\%\ SPR}$ (3 indices), 54% below (2 indices), 67% above (1 index) and equal to $F_{30\%\ SPR}$ (joint distribution)], the RFSAP felt that the best available information was based on the 3 index option because there was no reason to discount any of the tuning indices. The assessment results also indicated that reductions in fishing mortality are required to eliminate overfishing; however, the assessment did not take into account recent (1998) management actions that the RFSAP believed may be adequate to achieve the required reductions in F. Updated projections of the greater amberjack stocks by Turner and Scott (2002) revealed that effects of recent management actions by the Council had reduced F so that the stock was not undergoing overfishing. The ratio of $F_{current}$ to $F_{30\%SPR}$ had moved from 1.4 to 0.6 since 1998.

Secretarial Amendment 2 to the Reef Fish Fishery Management Plan to set Greater Amberjack Sustainable Fisheries Act Targets and Thresholds and to set a Rebuilding Plan was submitted to NOAA Fisheries in December 2002 for Secretarial review.

3.2.4.2.1.7 Gray triggerfish

The gray triggerfish is widely distributed in tropical and temperate waters throughout the Atlantic; in the Western Atlantic it ranges from Nova Scotia through Bermuda and the Gulf of Mexico to Argentina (Harper and McClellan 1997). This species is an important component of the Gulf of Mexico reef fishery, particularly for the recreational fishing sector (Goodyear and Thompson 1993). Prior to the 1980s, gray triggerfish were not considered a desirable catch by most fishers, but there has been an increase in targeting of this and other “under-utilized” species, probably caused by the decline in other reef fish stocks (e.g., red snapper and groupers).

There was an initial increase in average annual landings from 1.46 million pounds in 1986 to 2.88 million pounds in 1990. This was followed by a steady decline to 0.85 million pounds in 1998. The cause of this decline has not been determined, but it could be attributed to a consistent increase in fishing effort and a possible consequent decrease in stock size. In response to this problem, the first assessment for the gray triggerfish was published in March 2001 (Valle *et al*. 2001).

Standardized indices of abundance were estimated from five recreational and commercial fisheries data sets: the Marine Recreational Fishery Statistics Survey (MRFSS), the NOAA Fisheries' Southeast Fisheries Science Center (SEFSC) Headboat Survey, the Alabama Charterboat Survey, the Panama City Charterboat Survey, and the commercial Florida Logbook System Program. A sixth data set from the Texas Park and Wildlife Department (TPWD) Recreational Creel Survey was examined but the indices developed were not considered for subsequent analyses. The standardized indices were estimated using Generalized Linear Mixed Models under a delta lognormal model approach.

Catch-effort statistics from the recreational and commercial sectors for years 1986 to 1998 were used for stock assessment. The standardized catch rates were used to tune a non-equilibrium production model (ASPIC model).

Problems were encountered in the assessment. The model frequently failed to converge on a satisfactory solution, due to the limited time series of catch and effort data. Nevertheless, the authors considered there was reasonable evidence that the current rate of removal is not sustainable: a steady decline in landings since the peak in 1990 to a level (in 1998) that is below the MSY range. Estimated biomass levels are low and exploitation rates are high. The assessment concludes that the evidence suggests the stock is overfished, that overfishing is still occurring, and catches should be at least held constant, or preferably reduced to allow stock rebuilding (Valle *et al*. 2001). However, Blanchet did not feel that the stock assessment convincingly demonstrated that the stock was overfished (Blanchet, 2001). Because gray triggerfish exhibit high site fidelity, he saw the assessment as a description of a fishery that may well be undergoing local declines, with reduced CPUE in heavily fished areas. He felt that local regulations to address those declines, redistributing the harvest through creel or size limits, may be appropriate and should be based on social or economic information, not on a perception that the stock is being overharvested gulfwide.

3.2.4.2.1.8 Other managed species

Quantitative stock assessments do not currently exist for other managed reef fish species in the Gulf of Mexico. However, observations of declining abundance of Goliath grouper and Nassau grouper led the Gulf Council to set TAC for both species at zero; no commercial or recreational retention is allowed for either species. Low observed abundance led the Gulf Council to restrict harvest of speckled hind and Warsaw grouper to one fish per recreational vessel.

3.2.4.2.2 Habitat use by species in the Reef Fish FMU

3.2.4.2.2.1 Distribution of reef fish

In general, reef fish are widely distributed in the Gulf of Mexico, occupying both pelagic and benthic habitats during their life cycle. A planktonic larval stage lives in the water column and feeds on zooplankton and phytoplankton. Juvenile and adult reef fish are typically demersal and usually associated with bottom topographies on the continental shelf (<100m) which have high relief, i.e., coral reefs, artificial reefs, rocky hard-bottom substrates, ledges and caves, sloping soft-bottom areas, and limestone outcroppings. However, several species are found over sand and soft-bottom substrates. For example, juvenile red snapper are common on mud bottoms in the northern Gulf, particularly off Texas through Alabama. Also, some juvenile snapper (e.g. mutton, gray, red, dog, lane, and yellowtail snappers) and grouper (e.g. Goliath grouper, red, gag, and yellowfin groupers) have been documented in inshore seagrass beds, mangrove estuaries, lagoons, and larger bay systems (GMFMC, 1981b). More detail on hard bottom substrate and coral can be found in the Fishery Management Plan (FMP) for Corals and Coral Reefs (GMFMC and SAFMC, 1982).

The following sections briefly summarize the available information on habitat use and dependencies of all of the 42 species covered by the reef fish FMP. Tables 3.2.6 and 3.2.7 provides a summary of this information to demonstrate the important habitat dependencies of the reef fish complex.

Tables 3.2.6 and 3.2.7 show habitat associations for the various life stages of species for which information has been compiled to date. As maps and habitat tables of other species, or more sophisticated maps (i.e., GIS-based) become available, they will be included in future amendments.

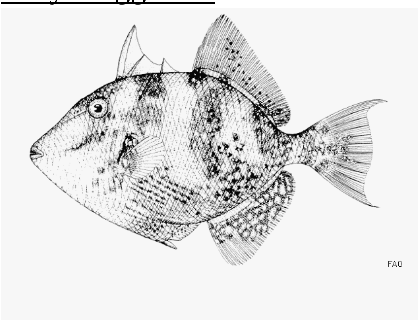
Levels of habitat use in the Gulf of Mexico by Reef Fish FMP species, calculated according to the method described in Section 2.1.4.2.1, are depicted in Figures 3.2.13a and b. For reef fish species in eco-regions 1 and 2, overall habitat use was highest for nearshore reefs, offshore hard bottoms, offshore reefs, offshore pelagic, and nearshore SAV (Table 3.2.30). For species in eco-regions 3 and 4, overall habitat use was highest for nearshore reefs, offshore hard bottoms, offshore reefs, offshore shelf edge/slope, and offshore sand/shell (Table 3.2.30). For species in eco-region 5, overall habitat use was highest for nearshore reefs, offshore hard bottoms, offshore reefs, offshore pelagic, and offshore sand/shell (Table 3.2.30).

3.2.4.2.2.2 Balistidae—Triggerfishes

FMP species list

Gray triggerfish	*Balistes capriscus*

Gray Triggerfish



Schneider 1990

The gray triggerfish is found throughout the Gulf of Mexico. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. Information is sparse, particularly for the early life stages (i.e., eggs, larvae and postlarvae). Eggs occur in late spring and summer in nests prepared in sand near natural and artificial reefs. Eggs are guarded by the female and/or male. Larvae and postlarvae are pelagic, occurring in the upper water column, usually associated with *Sargassum* and other flotsam. Early and late juveniles also are associated with *Sargassum* and other flotsam, and may be found in mangrove estuaries. Triggerfish leave the surface *Sargassum* habitat in the fall, when juvenile fish (5 to 7 inches) move to reef habitat on the bottom. Adults are found offshore in waters greater than 10 m where they are associated with natural and artificial reefs. However, triggerfish may move away from the reef structure in order to feed. They have been observed working soft bottoms by aiming a jet of water at the sand with enough force to reveal sand dollars and sea urchins hidden just under the surface. Spawning adults occur in late spring and summer, also around natural and artificial reefs in water depth greater than 10 m.

3.2.4.2.2.3 Carangidae—Jacks

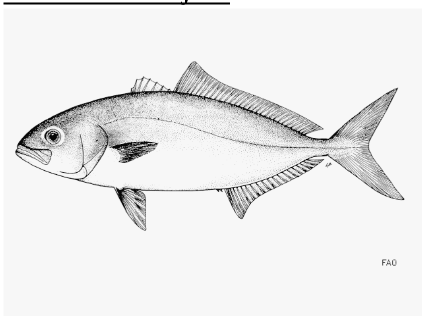
FMP species list

Greater amberjack	*Seriola dumerili*
Lesser amberjack	*Seriola fasciata*
Almaco jack	*Seriola rivoliana*
Banded rudderfish	*Seriola zonata*

Most carangids are believed to spawn offshore. Juveniles associate with floating objects such as clumps of *Sargassum*, bits of wood and debris, and jellyfish. As the fish grow, they drift inshore and assume an inshore schooling existence. However, some of the larger amberjacks follow a solitary existence.

Species-specific habitat use

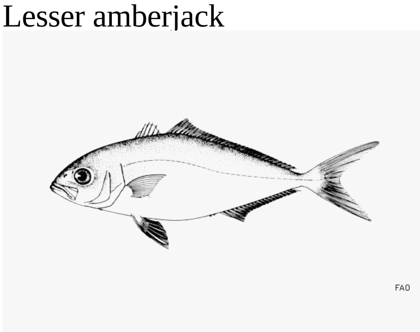
Greater Amberjack



Schneider 1990

The greater amberjack occurs throughout the Gulf coast to depths of 400 m. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. Information is sparse on habitat associations for all life stages of amberjack. Adults are pelagic and epibenthic, occurring over reefs and wrecks and around buoys. Very little information exists on spawning adults, but in the northern Gulf spawning occurs from May to July and may be as early as April based on histology. Juveniles also are pelagic and often attracted to floating plants and debris in the nursery areas that also are offshore (NOAA 1985).

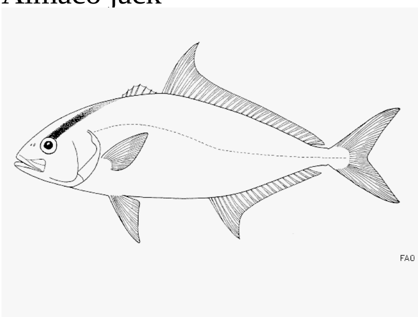
Lesser amberjack



Cervigón, F., *et al*. 1992

The lesser amberjack occurs Gulf-wide. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. Information is sparse, particularly for the early life stages (i.e., eggs, larvae and postlarvae). Juveniles occur offshore in the late summer and fall in the northern Gulf. Small juveniles are associated with floating *Sargassum*. Adults are found offshore year round in the northern Gulf where they are associated with oil and gas platforms and irregular bottom. Spawning occurs offshore September-December and February-March, probably in association with oil and gas structures and irregular bottom.

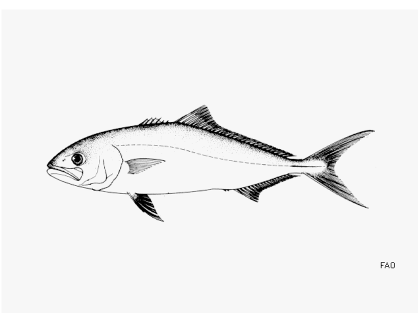
Almaco jack



Smith-Vaniz, W.F. 1995

The almaco jack is believed to occur throughout the Gulf of Mexico. Very little information is available on the habitat associations of the almaco jack. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. Juveniles use *Sargassum* as a refuge in open waters and off barrier islands. Adults are found far offshore, often associated with oil and gas platforms in the northern Gulf of Mexico. Spawning is thought to occur from spring through fall.

Banded Rudderfish



Cervigón, F., *et al*. 1992

Adult banded rudderfish are pelagic or epibenthic and confined to coastal waters over the continental shelf where they feed on fish and shrimps. They are not common in the central part of the northern Gulf of Mexico. They spawn in offshore waters of the eastern Gulf of Mexico, the Yucatan Channel and Straits of Florida. Juveniles occur in offshore waters and associate with jellyfish, such as *Physalia,* and drifting weeds, such as *Sargassum.* Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

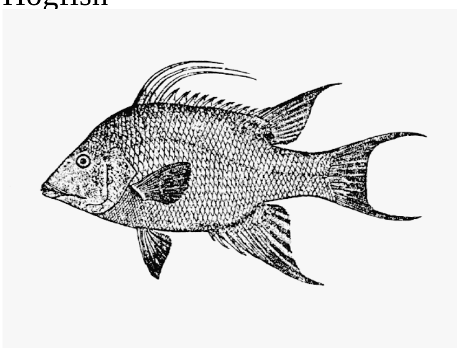
3.2.4.2.2.4 Labridae—Wrasses

FMP species list

Hogfish	*Lachnolaimus maximus*

General habitat use

Hogfish



Massey, L. L. and D. E. Harper 1993.

Hogfish are large wrasses that inhabit areas of moderate-high relief in shelf waters. They range from North Carolina, south through the Caribbean Sea and Gulf of Mexico, to the northern coast of South America. Juveniles can be found in shallow seagrass beds in Florida Bay where they feed on benthic crustaceans, mollusks, and echinoderms. Adults are widely distributed on coral reefs and rocky flats, where they consume bivalves, gastropods, sea urchins, crabs, and other mollusks (Sierra *et al.* 1994; Randall 1967). Adult hogfish feed mostly by winnowing hard shelled animals from the bottom substrate and crushing their prey with their pharyngeal jaws (Clifton and Motta 1998).

3.2.4.2.2.5 Lutjanidae—Snappers

FMP species list

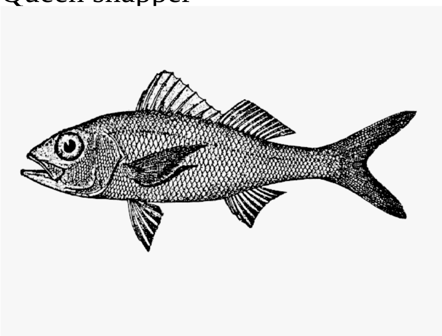
Queen snapper	*Etelis oculatus*
Mutton snapper	*Lutjanus analis*
Schoolmaster	*Lutjanus apodus*
Blackfin snapper	*Lutjanus buccanella*
Red snapper	*Lutjanus campechanus*
Cubera snapper	*Lutjanus cyanopterus*
Gray (mangrove) snapper	*Lutjanus griseus*
Dog snapper	*Lutjanus jocu*
Mahogany snapper	*Lutjanus mahogoni*
Lane snapper	*Lutjanus synagris*
Silk snapper	*Lutjanus vivanus*
Yellowtail snapper	*Ocyurus chrysurus*
Wenchman	*Pristipomoides aquilonaris*
Vermilion snapper	*Rhomboplites aurorubens*

General habitat use

Snappers are common in all warm marine waters of the world. Most are inshore dwellers, although some occur in open-water. Some species enter estuaries and mangroves, with the latter functioning as nursery grounds.

Species-specific habitat use

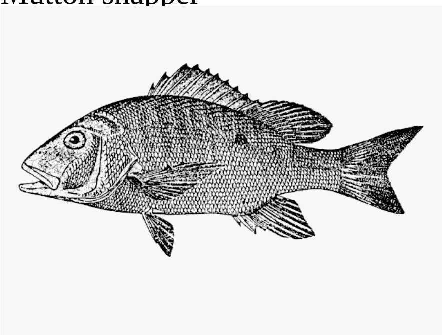
Queen snapper



Massey, L. L. and D. E. Harper 1993.

Very little information is available on the habitat associations of the queen snapper. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. Queen snapper are a deep-water species with adults distributed in the southern portion of the Gulf of Mexico where they commonly associate with rocky bottoms and ledges between 135 and 450 meters, feeding on small fish, squid and crustaceans.

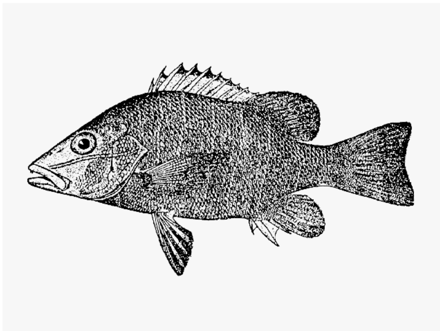
Mutton snapper



Massey, L.L. and D.E. Harper 1993. after Jordan and Fesler 1893, Plate 31.

Mutton snapper spawn on steep drop offs near reef areas, and larvae and post larvae are found in shallow continental shelf waters. Juveniles and adults inhabit shallow seagrass beds in tidal creeks and bights surrounded by mangroves, and in shallow protected bays. Adults are also found on patch reefs and deep barrier reefs and are most abundant off south Florida and in the Caribbean. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

Schoolmaster



Massey, L.L. and D.E. Harper 1993

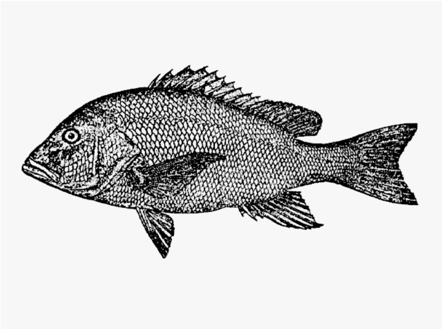
Schoolmasters occur throughout the Gulf, but are most common off western Florida and fairly rare in the northwestern Gulf (Hoese and Moore 1977). Juvenile schoolmaster occupy shallow and offshore habitats, moving to deeper offshore waters with growth. As juveniles they are associated with shallow seagrass beds and mangrove habitats, and congregate around jetties. Late juveniles are found over grass flats inshore and offshore rocky and coral reefs and may enter estuaries and mangrove habitats. Adult schoolmaster occur throughout coastal waters, from shallow water to about 90 m. They are found over various substrates including rock, vegetated sand, inshore and offshore reefs, esp. elkhorn coral, and mud. Late juveniles may enter mangrove swamps and tidal creeks due to their ability to tolerate low salinities. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

Blackfin snapper

Allen, G.R. 1985.

Blackfin snapper occurs throughout the Gulf, but is most common off of West Florida. This species of snapper occupies shelf edge habitats, where it feeds on fish and crustaceans. It is most commonly found at depths of 40 to 300 meters. Juveniles occur in shallower hard bottom areas at 12-40 meters. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

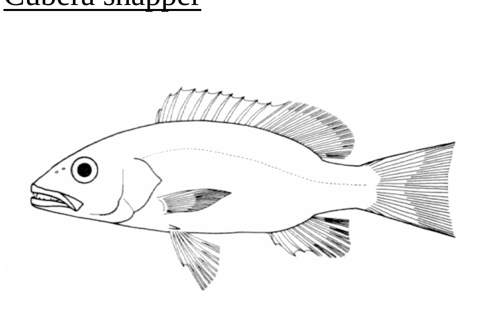
Red snapper



Massey, L.L. and D.E. Harper 1993

Red snapper occur throughout the Gulf of Mexico shelf. They are particularly abundant on the Campeche Banks and in the northern Gulf. The relatively high abundance once known on the shelf areas of west Florida was significantly reduced in the 1980s and 1990s (e.g. GMFMC 1981b), but recent evidence points to increasing abundance in this area (Mike Murphy, personal communication). Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. The species is demersal and is found over sandy and rocky bottoms, around reefs, and underwater objects from shallow water to 200 m, and possibly even beyond 1200 m. Adults favor deeper water in the northern Gulf. Spawning occurs in offshore waters from May to October at depths of 18 to 37 m over fine sand bottom away from reefs. Eggs are found offshore in summer and fall. Larvae, postlarvae and early juveniles are found July through November in shelf waters ranging in depth of 17 to 183 m. Early and late juveniles are often associated with structures, objects or small burrows, but also are abundant over barren sand and mud bottom. Late juveniles are taken year round at depths of 20 to 46 m. Adults are concentrated off Yucatan, Texas, and Louisiana at depths of 7 to 146 m and are most abundant at depths of 40 to 110 m. They commonly occur in submarine gullies and depressions, and over coral reefs, rock outcroppings, and gravel bottoms.

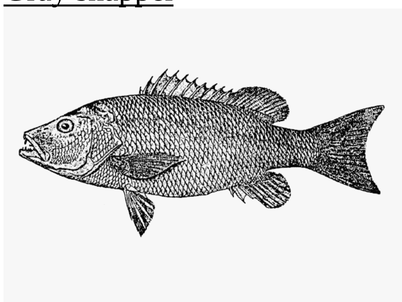
Cubera snapper



Menezes, N.A. and J.L Figueiredo 1980.

This species occurs infrequently in the Gulf of Mexico, but is most common off southwestern Florida. It is the largest of the snapper species occurring in the Western Atlantic. Adult cubera snapper are found on both shallow and deep reefs and wrecks (to at least 85 meters deep) and in mangroves. Unusual among snappers, they have a high range of salinity tolerance and can enter water that is nearly fresh (e.g. the intra-coastal waterway on the east coast of Costa-Rica). Adults feed on fishes, shrimps, and crabs, and notably spiny lobster. Juveniles are found in streams, canals, seagrass beds, mangrove areas, and lagoons. Spawning aggregations have been observed in June and July. Two spawning sites have been recorded in the eastern Gulf: both wrecks located in 67-85 m of water, off Key West and the Dry Tortugas. Similar aggregations have been recorded in Belize, Buttonwood Cay and Cay Bokel. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

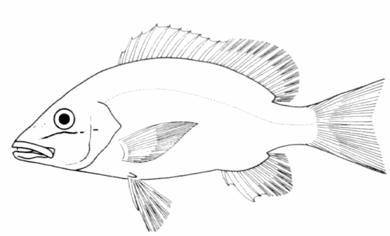
Gray snapper



Massey, L.L. and D.E. Harper 1993. after Jordan and Fesler 1893, Plate 28

Gray or mangrove snapper occur in estuaries and shelf waters of the Gulf and are particularly abundant off south and southwest Florida. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. Considered to be one of the more abundant snappers inshore, the gray snapper inhabits waters to depths of about 180 m. Adults are demersal and mid-water dwellers, occurring in marine, estuarine, and riverine habitats. They occur up to 32 km offshore and inshore as far as coastal plain freshwater creeks and rivers. They are found among mangroves, sandy grassbeds, and coral reefs and over sandy, muddy and rocky bottoms. Spawning occurs offshore around reefs and shoals from June to August. Eggs are pelagic, and are present June through September after the summer spawn, occurring in offshore shelf waters and near coral reefs. Larvae are planktonic, occurring in peak abundance June through August in offshore shelf waters and near coral reefs from Florida through Texas. Postlarvae move into estuarine habitat and are found especially over dense grass beds of *Halodule* and *Syringodium*. Juveniles are marine, estuarine, and riverine dwellers, often found in estuaries, channels, bayous, ponds, grassbeds, marshes, mangrove swamps, and freshwater creeks. They appear to prefer *Thalassia* grass flats, marl bottoms, seagrass meadows, and mangrove roots. More detailed information on habitat associations of gray snapper is provided in Nelson (1992) and Pattillo *et al.* (1997).

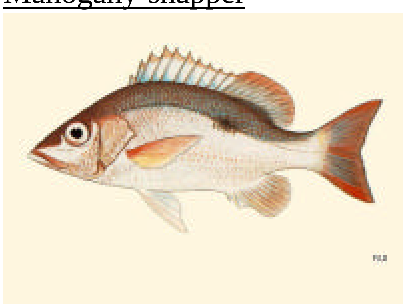
Dog snapper



Menezes, N.A. and J.L Figueiredo 1980.

Adult dog snapper are found throughout coastal areas of the Gulf, from shallow waters down to over 150 m depth. They occupy a diverse variety of habitats ranging from shallow vegetated areas to deep reefs. They are most commonly found on coral reefs and display territoriality, tending to occupy a home range. The diet comprises mainly fish, but can also include crustaceans and other invertebrates. Early juveniles are found on shallow water seagrass beds of coastal waters and estuaries, and may enter rivers. Late juveniles also occur around mangrove roots and jetties and pilings. Dog snapper tend to move to deeper water as they grow larger. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

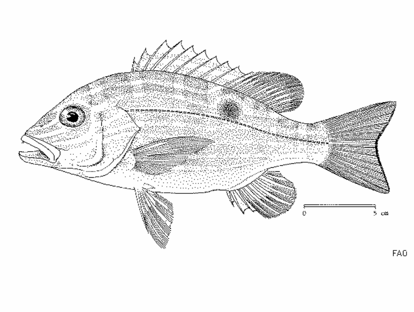
Mahogany snapper



Allen, G.R. 1985.

Adult mahogany snappers occur throughout the Gulf, especially around islands and in reef areas. They occupy a shallower range than other snappers, being found from shallow waters down to 30 meters. Specific habitat associations include rocky bottoms and reefs, where, like other snappers they feed on fish, crustaceans and invertebrates. They are less frequently found on sandy and vegetated bottoms. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

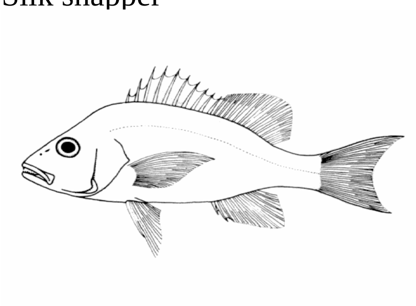
Lane snapper



Vergara, R. 1978.

Lane snapper occur throughout the shelf area of the Gulf in depths ranging from zero to 130 m. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. The species is demersal, occurring over all bottom types, but is most common in coral reef areas and sandy bottoms. Spawning occurs in offshore waters from March through September (peak July-August). Information on habitat preferences of larvae and postlarvae is non-existent and is in need of research. Nursery areas include the mangrove and grassy estuarine areas in southern Texas and Florida and shallow areas with sandy and muddy bottoms off all Gulf states. Early and late juveniles appear to favor grass flats, reefs, and soft bottom areas to offshore depths of 20 m (NOAA 1985). Adults occur offshore at depths of 4 to 132 m on sand bottom, natural channels, banks, and man-made reefs and structures.

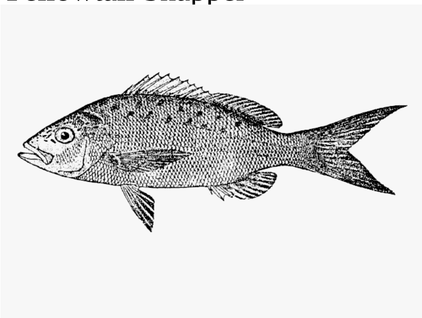
Silk snapper



Menezes, N.A. and J.L Figueiredo 1980.

Silk snapper are found across the Gulf, but are most common off southwestern Florida. Silk snapper is a deeper water species found near the edge of continental and island shelves, usually ascending to shallower waters at night. It is common between 90 and 140m, but is also found in deeper waters over 200m. Its diet consists of fish and crustaceans such as shrimps and crabs. Juveniles are found in shallower water than adults. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

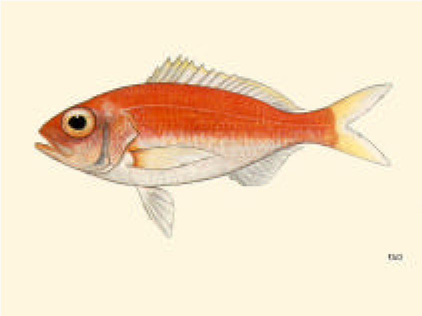
Yellowtail Snapper



Massey, L.L. and D.E. Harper 1993.

Yellowtail snapper are distributed throughout the shelf area of the Gulf of Mexico, but are most common off central and southern Florida. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. This species occurs over hard irregular bottoms, such as coral reefs and near the edge of shelves and banks. Spawning occurs February through October (peaks in February - April and September - October) in offshore areas. Information on eggs, larvae, and postlarvae is sparse and represents an area of needed research. Juveniles are found in nearshore nursery areas over vegetated sandy substrate and in muddy shallow bays (NOAA 1985). *Thalassia* beds and mangrove roots are apparent preferred habitat for early juveniles. Late juveniles apparently select shallow reef areas as primary habitat. Adults are found from shallow waters to depths of 183 m but generally are taken in less than 50 m depths. Adults are considered to be semi-pelagic wanderers over reef habitat.

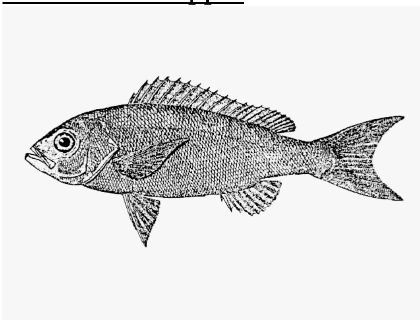
Wenchman



Allen, G.R. 1985.

Found throughout the Gulf, wenchman occupy hard bottom habitats of the mid to outer shelf where they feed mainly on small fish. They are found at depths ranging from 19 to 378 m, but are most abundant between 80 and 200 m. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

Vermilion Snapper



Massey, L.L. and D.E. Harper 1993.

Vermilion snapper are found throughout the shelf areas of the Gulf of Mexico, but are most common off West Florida. The species is demersal, occurring over reefs and rocky bottom from depths of 20 to 200 m. Spawning occurs from April to September in offshore waters. Juveniles occupy reefs, underwater structures and hard bottom habitats in 20 to 200 m depths (NOAA 1985). Information on habitat associations, depth ranges, and geographical distribution of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9.

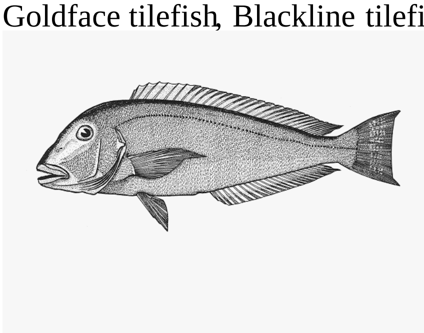
3.2.4.2.2.6 Malacanthidae—Tilefishes

Species list

Goldface tilefish	*Caulolatilus chrysops*
Blackline tilefish	*Caulolatilus cyanops*
Anchor tilefish	*Caulolatilus intermedius*
Blueline tilefish	*Caulolatilus microps*
Tilefish (golden)	*Lopholatilus chamaeleonticeps*

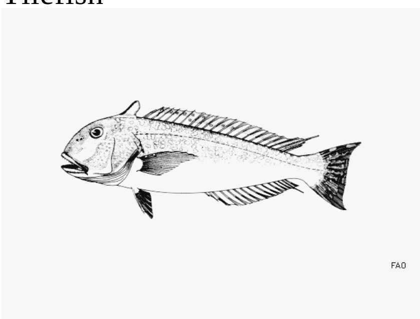
Species-specific habitat use

Goldface tilefish, Blackline tilefish, Anchor tilefish and Blueline tilefish



Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages of blueline tilefish in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. This information is used to provide inferences to goldface tilefish, *Caulolatilus chrysops*, blackline tilefish, *Caulolatilus cyanops*, and anchor tilefish, *Caulolatilus intermedius* as members of the same guild, with similar life histories and distributions. Blueline tilefish are distributed mainly on the eastern/southeastern Gulf of Mexico and the Campeche-Yucatan outer continental shelf, shelf edge and upper slope. Anchor tilefish are most common in the northern and western Gulf. Blueline tilefish are found over irregular bottom, including troughs and terraces, sand, mud and rubble, and shell hash. They may be associated with goldface tilefish and blackline tilefish and occur in the same habitat/fish assemblage as snowy, Warsaw, and yellowedge groupers, silk and vermilion snappers and *Pagrus pagrus*, the common seabream. They construct burrows in soft sediments and may also utilize existing holes and crevices. Blueline tilefish are epibenthic browsers; feeding primarily on benthic invertebrates, and also some demersal fishes. Larger adults feed increasingly on fish.

Tilefish



Tilefish (also known as golden tilefish) occur throughout the deeper waters of the Gulf of Mexico. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. The species is demersal, occurring at depths from 80 to 450 m, but is most commonly found between depths of 250 to 350 m. Preferred habitat is rough bottom and steep slopes. Spawning occurs in the months of March to November throughout the species range. Eggs and larvae are pelagic; early juveniles are pelagic-to-benthic. Nursery areas are found throughout the species range (NOAA 1985). Late juveniles burrow and occupy shafts in the substrate. Adults also dig and occupy burrows along the outer continental shelf and on flanks of submarine canyons.

3.2.4.2.2.7 Serranidae—Groupers

Species list

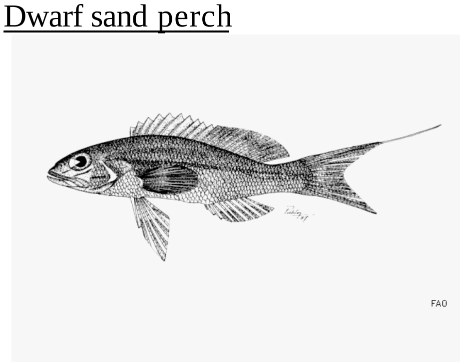
Dwarf sand perch	*Diplectrum bivittatum*
Sand perch	*Diplectrum formosum*
Rock hind	*Epinephelus adscensionis*
Speckled hind	*Epinephelus drummondhayi*
Yellowedge grouper	*Epinephelus flavolimbatus*
Red hind	*Epinephelus guttatus*
Goliath grouper	*Epinephelus itajara*
Red grouper	*Epinephelus morio*
Misty grouper	*Epinephelus mystacinus*
Warsaw grouper	*Epinephelus nigritus*
Snowy grouper	*Epinephelus niveatus*
Nassau grouper	*Epinephelus striatus*
Black grouper	*Mycteroperca bonaci*
Yellowmouth grouper	*Mycteroperca interstitialis*
Gag grouper	*Mycteroperca microlepis*
Scamp	*Mycteroperca phenax*
Yellowfin	*Mycteroperca venenosa*

General habitat use

The serranids form a large and important element of the tropical marine fish faunas around the world. Of the species included in the Reef Fish FMP, most are carnivorous bottom dwellers, associated (as adults) with hard-bottomed substrates, and rocky reefs, with the exception of the sand perches, which are found on soft bottoms and grassy areas.

Species-specific habitat use

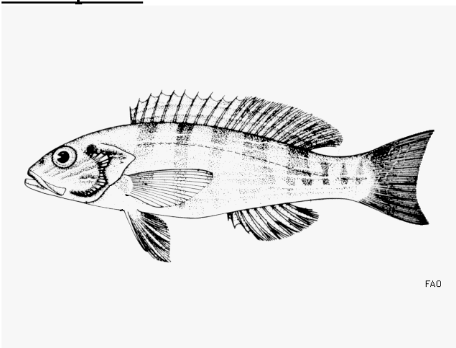
Dwarf sand perch



.
Cervigón, F, *et al*. 1992

Adult dwarf sand perch are found throughout the Gulf on soft bottoms (Cervigón *et al.*1992). Information on habitat associations, depth ranges, and the geographical distribution of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9.

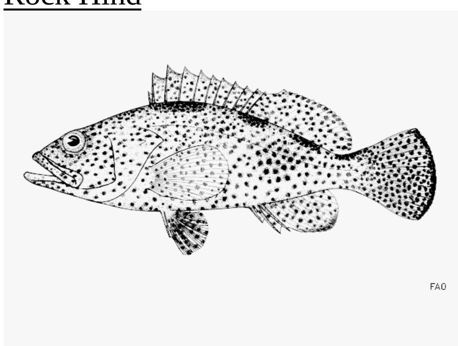
Sand perch



Cervigón, F., *et al*. 1992

Adult sand perch inhabit bays, coastal grassy areas and shallow banks in the northern Gulf of Mexico, particularly off the coast of Florida. They are solitary and retreat into shelter when frightened. Information on habitat associations, depth ranges, and the geographical distribution of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9.

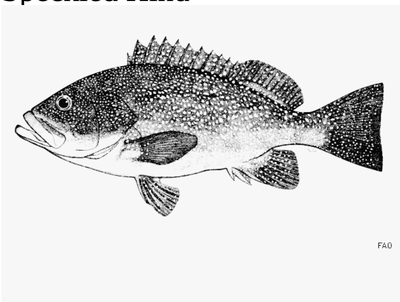
Rock Hind



Heemstra, P.C. and J.E. Randall, 1993.

The rock hind occupies shallow hard bottom habitats, including coral and rocky reefs; rock piles, oil and gas platforms, high profile–steep crevices and ledges. Adults occur from 2 to 100 m, but larger adults are more common in deeper waters (50-100 m). The species is usually captured in waters more than 30 m deep off the west Florida shelf. They feed on crustaceans, (especially crabs) and fishes. Rock hind grow faster and are shorter-lived than most other groupers. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

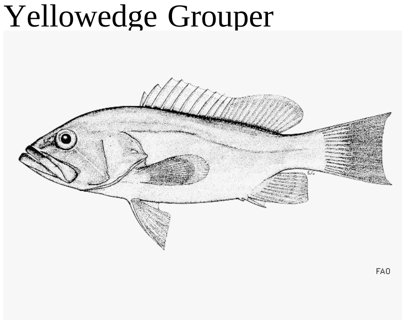
Speckled Hind



Heemstra, P.C. and J.E. Randall 1993

The speckled hind is a deep water grouper distributed in the north and eastern Gulf of Mexico on offshore hard bottom habitats, including rocky bottoms and both high and low profile hard bottoms. Adults are considered to be an apex predator on midshelf reefs, feeding on a variety of fishes, invertebrates and cephalopods. They occur between 25 to 183 meters and are most common at 60-120 meters depth. Juveniles are most commonly found in the shallow portion of the depth range. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

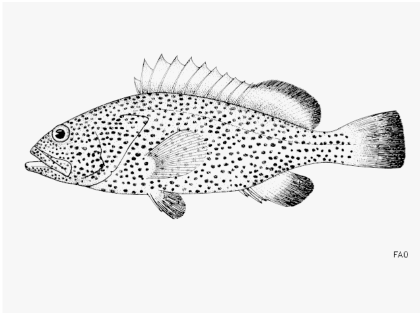
Yellowedge Grouper



Heemstra, P.C. and J.E. Randall 1993.

Yellowedge grouper is another deep water species found throughout the Gulf continental shelf, with areas of high abundance off of Texas and west Florida. On the outer continental shelf, the species occupies high relief hard bottoms, rocky out-croppings and is often found co-occuring with snowy grouper and tilefish. Both adults and juveniles are also known to inhabit burrows. Major components of the diet comprise brachyuran crabs, fishes and other invertebrates. The species depth range is from 35 to 370 m with adults most common in waters greater than 180 meters deep. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

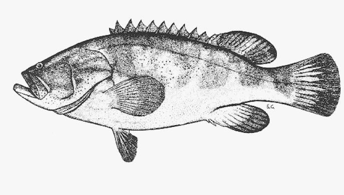
Red hind



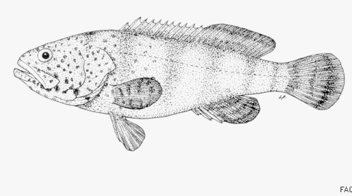
Heemstra, P.C. and J.E. Randall 1993

Within the Gulf of Mexico, the red hind is most abundant in southeastern Gulf reef areas. It occupies reefs, stony coral, and actively seeks holes and crevices. It may also be found on sandy bottoms with isolated coral patches and low-relief habitats. The species depth range is 18 to 110 m, with inshore populations being mostly female. Juveniles occupy patch reefs, coral and limestone rock, and move deeper as they increase in size. The diet comprises crustaceans (especially brachyuran crabs), fishes and other invertebrates. Spawning occurs in late spring and summer on the Florida Middle Grounds, where fish aggregate on the seaward side of submerged ridges. Individuals of this species are known to return to the same spawning site. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

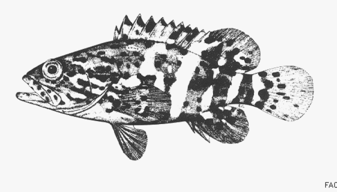
Goliath grouper



Heemstra, P.C. 1995



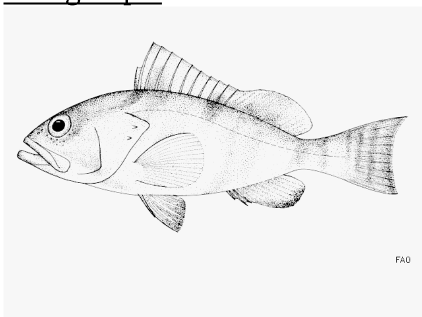
Heemstra, P.C. 1995



Schneider, W. 1990

Goliath grouper are a protected species found in the shallow waters of the Gulf of Mexico, and are most abundant on the southwest Florida and Campeche Banks. Younger adults are found inshore around docks, bridges and jetties, and reef crevices, while large adults prefer offshore ledges and wrecks. The species depth range in the Gulf is down to 95m, with the highest abundance at 2-55m. Early juveniles are found in bays and estuaries, inshore grassbeds, canals, and mangroves. Larger juveniles are also found around ledges, reefs, and holes in shallow waters. Adults feed mainly on crustaceans, (especially lobsters), fish, and mollusks (cephalopods). The diet of juveniles is mainly blue crabs and other crustaceans. Spawning occurs from June to December with peaks between July and September. Spawning occurs off southeast and southwest Florida, and other parts of the Gulf around offshore structures, wrecks and patch reefs (i.e. high-relief structures). Spawning aggregations can contain 10-150 individuals and have been reported from depths of 36-46m. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

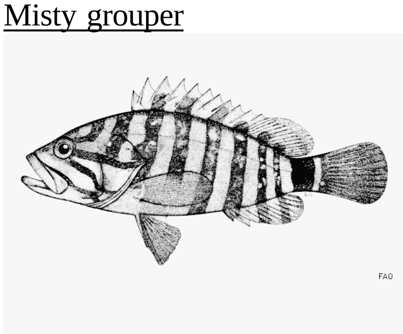
Red grouper



Heemstra, P.C. and J.E. Randall 1993

The red grouper is demersal and occurs throughout the Gulf of Mexico at depths from 3 to about 200 m, preferring 30 to 120 m depths. It is particularly abundant off west Florida and the Yucatan coasts. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. Spawning occurs at depths of approximately 40 to 120 m on the Florida Banks with peaks during April and May. Adults spawn in the same areas where they reside and do not aggregate. Spawning sites are low-relief habitats often near solution holes. Eggs are pelagic and require at least 32 ppt salinity for buoyancy. Larvae leave the planktonic stage to become benthic at about 20 mm standard length. Late juveniles select inshore hard bottom to depths of about 50 m, seeking shelter in crevices and other hiding places. Favored nursery areas for juveniles are grass beds, rock formations, and shallow reefs. Juveniles remain in the nursery areas until mature before moving to deeper Gulf waters (NOAA, 1985). Adults select rocky outcrops, wrecks, reefs, ledges, crevices and caverns of rock bottom, as well as "live bottom" areas, in depths of 3 to 190 m. Spawners occur in offshore coastal waters in depths of 20 to 100 m.

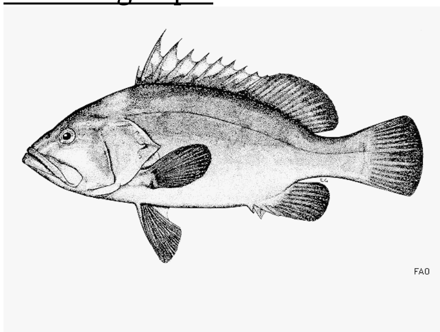
Misty grouper



Heemstra, P.C. and J.E. Randall 1993

Misty Grouper is a deep-water grouper found offshore throughout the Gulf on hard-bottom slope and shelf substrates, including high-relief rocky ledges and pinnacles. Adults occur mainly between 100 and 400 m, with juveniles distributed in shallower water. Adults feed on crustaceans (especially crabs), fishes and cephalopods. Spawning occurs April through July in the Gulf. Information on habitat associations, depth ranges, and the geographical distribution of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9.

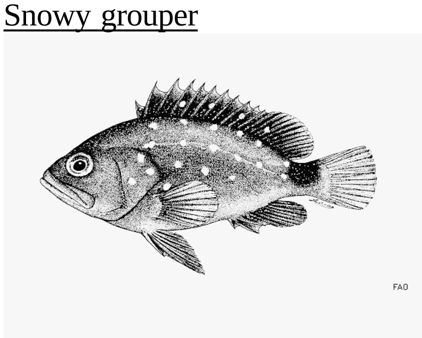
Warsaw grouper



Heemstra, P.C. and J.E. Randall 1993

Habitat associations of the Warsaw grouper are similar to those of the misty grouper. Both are deep-water species distributed throughout the Gulf of Mexico, in association with hard bottoms. Warsaw grouper occur from 40 to 525 m, more commonly down to 250 m, and prefer rough, rocky bottoms with high profiles such as steep cliffs and rocky ledges. Adults feed on crabs, shrimp, lobsters, and fish. Early juveniles occur in shallow nearshore habitats and may enter bays, moving into deeper water as they grow. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

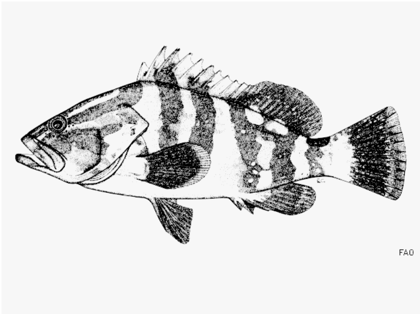
Snowy grouper



Heemstra, P.C. and J.E. Randall 1993

In the Gulf of Mexico, snowy grouper are found in largest numbers in deep waters off of South Florida and the northwestern coast of Cuba. They occur on rocky bottoms, well offshore, such as around boulders and ridges, and relief up to 10 m interspersed with sand shell and rock fragments. They are common on Florida Oculina reefs and are often found with other deep-water species such as yellowedge grouper and tilefishes. Adults feed on fish, crabs and other crustaceans, cephalopods and gastropods. As with other groupers, the young occur in shallower habitats, such as nearshore reefs, and move into deeper water with growth. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

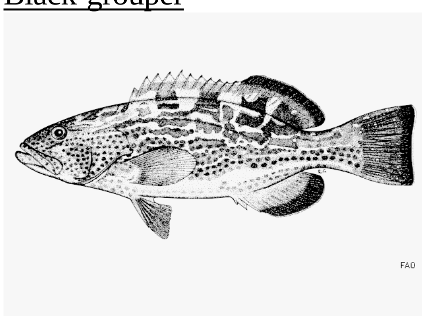
Nassau grouper



Heemstra, P.C. and J.E. Randall 1993

Nassau grouper is a protected species that occupies reefs and crevice caves down to about 100 m depth. Older fish tend to occur in deeper waters than younger individuals. Presently, they are found primarily along the Keys reef tract although they are uncommon. The diet is not particularly specialized, comprising crustaceans and fish. Spawning aggregations are formed in areas of soft corals, sponges, stony corals, and sand from December to February coordinated with the times of the full moon. Early juveniles associate with inshore seagrass beds, macroalgal mats, tilefish mounds and small coral clumps. Later juveniles become piscivorous at 20-25 cm TL and move to offshore reefs at 30-35cm TL. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

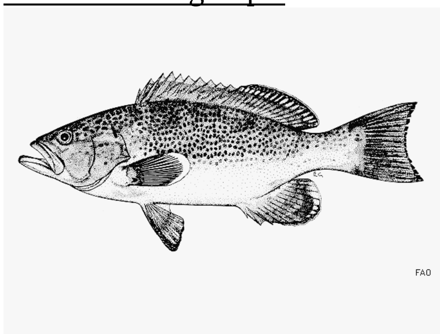
Black grouper



Heemstra, P.C. and J.E. Randall 1993

The black grouper is found along the eastern Gulf of Mexico and Yucatan Peninsula, but is considered rare in the western half of the Gulf. The species is demersal and is found from shore to depths of 150 m. Adults occur over wrecks and rocky coral reefs, irregular bottoms, ledges and high-to-moderate relief habitat. Spawning occurs from late winter through to spring and summer throughout all adult areas. Ripe females were found in May on Campeche Banks, and late winter-spring in the eastern Gulf with peak activity in January to March. Spawning aggregations have been observed in the Florida Keys at 18 to 28 m depth. Juveniles occupy shallow water reefs and rocky bottoms and patch reefs. They may also be found over muddy bottoms of mangrove lagoons and may venture into estuaries occasionally (NOAA 1985). They move to deeper water with growth. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

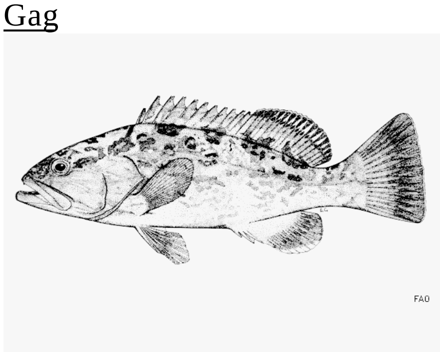
Yellowmouth grouper



Heemstra, P.C. and J.E. Randall 1993

In the Gulf of Mexico, yellowmouth grouper occur off of the Campeche Banks, the west coast of Florida, Texas Flower Garden Banks, and the northwest coast of Cuba. They occupy rocky bottoms and coral reefs and feed on fishes, and also crustaceans and other invertebrates. Spawning occurs primarily in spring and summer, with peaks in April and May off the west coast of Florida. Juveniles commonly occur in mangrove-lined lagoons and move into deeper water as they grow. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

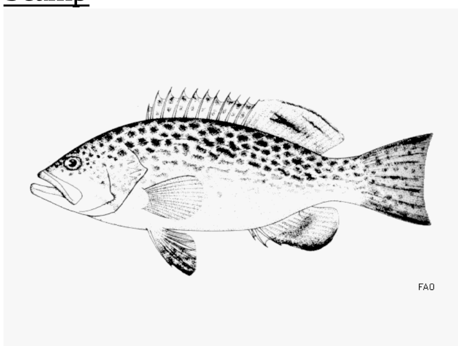
Gag



Heemstra, P.C. and J.E. Randall 1993

Gag are demersal and most common in the eastern Gulf, especially the west Florida shelf. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. Adults occupy hard bottom substrates, including offshore reefs and wrecks, coral and live bottoms, and depressions and ledges. Spawning adults form aggregations in depths of 50 to 120 m, with the densest aggregations occurring around the Big Bend area of Florida. Spawning occurs near the shelf edge break during December-April with a peak in the early spring (February-March) on the west Florida shelf. Madison-Swanson is a 298 square km (115 square mile) area, south of Panama City, Florida, containing high-relief hard bottom habitat, and is a known spawning ground for gag. Eggs are pelagic, occurring in December-April, with areas of greatest abundance offshore on the west Florida shelf. Larvae are pelagic and are most abundant in the early spring. Postlarvae and pelagic juveniles move through inlets into coastal lagoons and high salinity estuaries in April-May where they become benthic and settle into grass flats and oyster beds. Late juveniles move offshore in the fall to shallow reef habitat in depths of one to 50 m. Adults are found in deeper waters (10 to 100 m) on hard bottoms, offshore reefs and wrecks, coral, and live bottom.

Scamp



Cervigón, F., *et al.* 1992

Scamp are demersal and widely distributed throughout shelf areas of the Gulf, especially off Florida. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C. As with many of the reef species, detailed information on habitat relationships is sparse. Adults occupy ledges and high relief hard bottoms in depths of 12-189 m, but most are captured at 40-80 m depths. They prefer complex structures such as *Oculina* coral reefs. They are primarily piscivorous, but also feed on crustaceans and cephalopods. Spawning adults have been taken at depths of 50-120 m. Spawning occurs from late February to early June in aggregations with a peak during March-May. Scamp prefer to spawn at the shelf edge and have been observed in apparent spawning locations used by gag grouper. *Oculina* formations are a key spawning habitat. Eggs and larvae are pelagic, occurring offshore in the spring. Early and late juveniles occur on inshore hard bottoms and reefs in depths of 12-33 m.

Yellowfin grouper

Cervigón, F., *et al.* 1992

The yellowfin grouper is not common in the Gulf of Mexico, occurring primarily in the southern Gulf and West Indies. Its habitat comprises rocky bottoms and coral reefs from the shoreline to mid-shelf depths. These groupers prefer reef ridge and high-relief spur and groove reefs. Adults feed primarily on fish, but also on squid and shrimp. This species is able to capture swift-moving fish. Juveniles occupy shallow seagrass beds and move to deeper rocky bottoms with growth. Spawning takes place from March to August in the eastern Gulf. Juveniles occupy shallow seagrass beds and move to deeper rocky bottoms as they increase in size. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.6-3.2.9 and Appendix C.

3.2.4.2.3 Prey of species in the Reef Fish FMU

With 42 species of reef fish in the management unit, the prey of this species complex is rich and varied (GMFMC 1981b). Habitat important to the prey of reef fish species ranges from the estuaries to the offshore reefs and adjacent sand and mud bottom areas. Prey dependence is one factor that determines the importance of these habitats for reef fish.

Many species of snapper and grouper occupy inshore areas during their juvenile stages (e.g., mutton, dog, lane, gray and yellowtail snapper; and Goliath grouper, red, gag, and yellowfin groupers) where they feed on estuarine dependent prey (e.g., shrimp, small fish and crabs). As they mature and move offshore, their diets in many cases focus more on fish, but estuarine-dependent species can still constitute an important dietary component.

Many reef fish species are considered to be unspecialized, opportunistic feeders: feeding on a variety of fishes and crustaceans (Parrish 1987). In general, these species prey primarily on crustaceans early in life but target fish as they grow larger. The gray snapper is a good example of a species with widely diverse habitat and feeding regimens. This species is classified as an opportunistic carnivore at all life stages (Pattillo *et al*. 1997). During the juvenile stage in the estuarine environment, the gray snapper feeds on small shrimp, copepods, amphipods and larval fish. On offshore reefs, adults feed primarily on fish and secondarily on crustaceans. Likewise, the red snapper is basically carnivorous, feeding mainly on fish and squid. Juvenile red snapper often feed on shrimp but become more piscivorous after age one. Of the vertebrates consumed, most are not obligate reef dwellers, indicating that red snapper feed away from reefs (GMFMC

1981b). In general, groupers are considered to be unspecialized, opportunistic feeders consuming a variety of fishes and crustaceans. For more information on specific feeding habits of other reef fish species see GMFMC (1981b).

Common prey species of Managed Reef Fish:

Reef Fish Common Name	Taxa	Prey
Queen snapper	*Etelis oculatus*	No data available
Mutton snapper	*Lutjanus analis*	Crustaceans, fishes, gastropods
Schoolmaster	*Lutjanus apodus*	Crabs, shrimps, fishes
Red snapper	*Lutjanus campechanus*	Squids, fishes, gastropod larvae
Cubera snapper	*Lutjanus cyanopterus*	Snappers, grunts, parrotfishes, and porcupine fishes
Gray snapper	*Lutjanus griseus*	Shrimps, copepods, amphipods, and larval fishes
Dog snapper	*Lutjanus jocu*	Reef fishes, crustaceans and mollusks
Mahogany snapper	*Lutjanus mahogoni*	Reef fishes, shrimps, crabs and octopods
Lane snapper	*Lutjanus synagris*	Copepods, grass shrimps, fishes, crustaceans, annelids, and mollusks.
Silk snapper	*Lutjanus vivanus*	Fishes, shrimps, crabs, isopods, ophiuroids, squids, octopods, stomatopods, also tunicates
Yellowtail snapper	*Ocyurus chrysurus*	Planktivorous, also feed on benthic and pelagic reef fishes, crustaceans and mollusks
Wenchman	*Pristipomoides aquilonaris*	No data available
Vermilion snapper	*Rhomboplites aurorubens*	Ostracods, copepods, stomatopods, amphipods, euphausids, squids, pteropods, heteropods, and fishes
Rock hind	*Epinephelus adscensionis*	Invertebrates and fishes
Speckled hind	*Epinephelus drummondhayi*	Euryphagic carnivore
Yellowedge grouper	*Epinephelus flavolimbatus*	Squids, no more data available
Red hind	*Epinephelus guttatus*	*Mithrax* and *Callapa* crabs, scyllarid lobsters, alphaeid shrimps, wrasses, parrotfishes and grunts
Goliath grouper	*Epinephelus itajara*	Fishes, hawksbill turtles, crabs, and slipper and spiny lobsters
Red grouper	*Epinephelus morio*	Fishes, octopods, shrimps, portunid and *Callapa* crabs, stomatopods, and palinurid and scyllarid lobsters

Reef Fish Common Name	Taxa	Prey
Misty grouper	*Epinephelus mystacinus*	Fishes and squids
Warsaw grouper	*Epinephelus nigritus*	No data available
Snowy grouper	*Epinephelus niveatus*	No data available
Nassau grouper	*Epinephelus striatus*	Fish crabs, other crustaceans cephalopods, pelecypods, and gastropods
Black grouper	*Mycteroperca bonaci*	Small fishes and crabs
Yellowmouth grouper	*Mycteroperca interstitialis*	Fishes
Gag grouper	*Mycteroperca microlepsis*	No data available
Scamp	*Mycteroperca phenax*	No data available
Yellowfin grouper	*Mycteroperca venenosa*	No data available

3.2.4.3 Coastal Migratory Pelagic FMU

Species in the Management Unit

King mackerel	*Scomberomorus cavalla*
Spanish mackerel	*S. maculatus*
Cobia	*Rachycentron canadum*

Species in the Fishery but not in the Management Unit

Cero	*S. regalis*
Little tunny	*Euthynnus alleteratus*
Dolphin	*Coryphaena hippurus*
Bluefish (Gulf of Mexico only)	*Pomatomus saltatrix*

3.2.4.3.1 Status of stocks

The Coastal Migratory species range in coastal and continental shelf waters from the northeastern United States through the Gulf of Mexico.

The Coastal Migratory Pelagic "Mackerel" FMP, approved in 1982 and implemented jointly for the Gulf of Mexico and South Atlantic regions by regulations effective in February of 1983, treated king and Spanish mackerel each as one U.S. stock. Allocations were established for recreational and commercial fisheries, and the commercial allocation was divided between net and hook-and-line fishermen Total allowable catch and commercial and recreational allocations are established for two distinct migratory groups of king and Spanish mackerel, the Gulf group and the Atlantic group.

Tables 3.2.10 and 3.2.11 show management regulations and harvest data for Gulf and Atlantic group king and Spanish mackerel since 1987/88. More limited information is available to assess the status of cobia, dolphin, and little tunny stocks in the Gulf. This information is included in the following sections. There is insufficient information to assess the status of bluefish and cero in the Gulf.

3.2.4.3.1.1 King mackerel

Before 1985 king mackerel were considered to be a single stock ranging from the western Gulf through the Mid-Atlantic/New England areas. In 1985, assessment information became available indicating that there were separate migratory groups for the Gulf of Mexico and Atlantic areas with a mixing zone off southeast Florida. This information further indicated that Gulf group king mackerel were overfished. In October 1985, the Council requested that NOAA Fisheries implement an emergency rule to reduce the Gulf group king mackerel TAC from 14.4 to 5.2 million pounds, and this was done on March 1986. Later in 1986, the Council reduced the TAC to 2.9 million pounds by regulatory amendment, and in 1987 reduced TAC again to 2.2 million pounds (by regulatory amendment) (Table 3.2.10). As shown in Table 3.2.10, recreational catches have dominated the Gulf group king mackerel fishery with an allocation of 68% of TAC. Furthermore, because the recreational fishery has only been constrained by bag and size limits and not a quota, except during the early years of management (as opposed to the commercial fishery), fairly significant overruns of TAC occurred until approximately 1997. Commercial overruns of TAC also occurred during this period; however, they were not as great (Table 3.2.10). Since 1997, the recreational catch has dropped; whereas the commercial catch has remained relatively stable.

Based on the Council's proposed definitions for overfishing and the overfished condition for Gulf group king mackerel the stock would not have been considered as either overfished nor undergoing overfishing since at least 2000 (MSAP 2000, 2001, 2002). Furthermore, since the transitional spawning potential ratio [SPR]) has remained at approximately the same level (approximately 22% to 28%) since at least 1992 (including the 2000, 2001, and 2002 assessments), it is questionable if the stock would have been considered as overfished during this period under the proposed default control rule assessment methodology currently being used. Although the Gulf group king mackerel stock is no longer considered as overfished or undergoing overfishing, the current spawning stock biomass (SS) is below $SS_{MSY.}$ However, Fcurrent is below F_{MSY}; consequently the stock is expected to continue to recover under the present management strategy. Although the current TAC is set at 10.2 million pounds, catches in the most recent years have approximated catches at the ABC range for OY (7.0 million pounds to 8.0 million pounds). Consequently, further rebuilding is expected to the target SSoy level in the future.

3.2.4.3.1.2 Spanish mackerel

As shown in Table 3.2.11, Gulf group Spanish mackerel landings varied from 4-7 million pounds from1987-88 to 2000-01 (MSAP 2002). Landings declined significantly to less than 3 million pounds in the mid 1990s due to loss of markets and the gill net ban in Florida. Landings increased to approximately 4 million pounds in 1999-00 and 2000-01. The original allocation of TAC based on historical catches was 57% commercial and 43% recreational. However, since the net ban in 1995 recreational catches have generally been more than double the commercial catches.

Gulf group Spanish mackerel were assessed in 1999 using data through the 1997 fishing year. Based on the Council's proposed definitions for overfishing and the overfished condition for Gulf group Spanish mackerel, the stock is not considered as either overfished or undergoing overfishing (MSAP 2001). Recent catch levels are less than half of the recommended TAC under the OY target of F40% SPR. Furthermore, SScurrent is above SSmsy (Table 3.2.11, MSAP 2001).

3.2.4.3.1.3 Dolphin

Dolphin have a short life span, fast growth rate, and high natural mortality; thus their abundance in any given year is highly dependent on environmental factors. Consequently, recreational and commercial landings of dolphin in the Gulf of Mexico have been highly variable since 1984. Landings from 1984 to 2000 ranged from approximately 1.15 million pounds in 1984 to approximately 11.4 million pounds in 1997 with landings in most years ranging between 3.0 million pounds and 6.0 million pounds.

Prager (2000) assessed the dolphin stocks in the Gulf of Mexico, South Atlantic, and Caribbean as one stock; however, he noted that there were differences in various vital rates among regions, particularly the Gulf. Prager (2000) noted that dolphin were an extremely fast growing and early maturing stock with a high natural mortality value (M)=0.6-0.8. He concluded that F1997 to Fmsy was approximately 50%, and B1998 to Bmsy was approximately 156%. Consequently, the stock was neither undergoing overfishing nor overfished. Furthermore, MSY was estimated at approximately 27 million pounds per year, and average annual catches for the last 5 years were approximately 16 million pounds. Thus, there is little chance that the stock would become overfished unless fishing mortality drastically increased.

3.2.4.3.1.4 Little tunny

The Gulf of Mexico little tunny are considered as a separate stock, and no mixing seems to be occurring with the Atlantic stock (Brooks 2002). Historically, most catches and landings occur in Florida, which generally accounts for 80% of all landings. Recreational landings dominated the catch since recreational data became available in 1981, except for a period in the early 1990s when commercial catches increased to levels comparable to recreational. Average annual landings for the last 5 years were approximately 1.0 million pounds, which is well below the estimated annual MSY of 1.55 million pounds (MSAP 2002). Both the MRFSS and the headboat standardized CPUE indices showed declines in abundance from the mid-1980s to the mid-1990s. This period of declining abundance coincided with the years that total landings peaked. These CPUE indices appear relatively stable since about 1995 or 1996.

Based on the ASPIC surplus production model, F exceeded F_{MSY} during the period 1990 to 1995, and thereafter fell to below F_{MSY}. Concomitantly, B dropped below B_{MSY} in 1993 and has thereafter increased to a 2002 level of approximately 96% of B_{MSY}. Consequently, the little tunny stock in the Gulf would not be considered as overfished or undergoing overfishing. Furthermore, the stock has very nearly recovered to B_{MSY}, and at current F values should recover above B_{MSY} in the near future (MSAP 2002).

3.2.4.3.1.5 Cero

Recreational and commercial fishery data indicated that cero landings in the United States are primarily concentrated in the south Florida region particularly in the area of the Florida Keys and along Florida's southeast coast (Turner and Brooks 2002).

Cero have not been distinguished from king mackerel in the Southeast Fisheries Science Center accumulated landings system, so commercial catches of cero have not been tabulated. The commercial catch sampling system (the Trip Interview Program, TIP) does record information on species composition of catches and might contain information, which could be used to attempt to disaggregate the cero and king mackerel catches.

Analyses of cero population dynamics using production models or age-based models were not attempted because the commercial catch was not known (Turner and Brooks 2002). However some inferences can be made from the patterns in catch and catch rates. Turner and Brooks (2002) used catch rate indices from the MRFSS and headboat data sets to evaluate trends in abundance.

The catch rate indices suggest that the population has fluctuated during the 1990s, but without a consistent increase or decrease over the decade.

Recreational catch levels were generally similar between the 1980s and 1990s in both the MRFSS and the headboat relative catch levels.

Turner and Brooks (2002) described cero as a tropical and subtropical species that is concentrated in the Bahamas, Jamaica, and the West Indies. Catches occur off south Florida, in the Gulf of Mexico (an isolated area off northeast Texas and Louisiana), and off Brazil. As of yet, there is no definite answer as to whether the Gulf of Mexico cero and the Caribbean cero should be considered under the same biological stock. MSAP (2002) concluded that the stock status of cero could not be determined, and trends in abundance may be related to environmental changes as well as population size.

3.2.4.3.1.6 Bluefish

Catches of bluefish in the Gulf of Mexico have shown a declining trend since the mid to late 1980s for both the recreational and commercial sectors. CPUE indices for both the MRFSS and headboat surveys also show a declining trend in the late 1990s as opposed to the 1980s and early 1990s. Because of limitations on available data the status of the bluefish stocks in the Gulf cannot be determined at this time (MSAP 2002). However, the reduction in both recreational and commercial catches and the decline in recreational CPUE estimates warrant concern, and regulatory actions may be needed in the near future.

3.2.4.3.1.7 Cobia

Table 3.2.12 shows that annual commercial cobia landings increased significantly from approximately 1992 to 1997. A similar trend is evident in the CPUE indices of the recreational MRFSS, headboat, and Texas creel surveys (MSAP 2001). Additionally, recreational catches have accounted for approximately 90% of the total landings over the 1981-2000 period.

MSAP (2001) and Williams (2001) observed that F2000 was estimated at 0.67 and there was a 40% chance that F2000 was greater than F_{MSY}. Biomass in 2000 was estimated at 1.33 and there was a 30% chance that B2000 was less MSST, defined as 70% of B_{MSY}. Consequently, under the Council's proposed status determination criteria, cobia would not be considered as overfished or undergoing overfishing. Furthermore, catches in recent years have been approximately 1.1 to 1.2 million pounds and below the estimated MSY of 1.5 million pounds. Additionally, these recent catches have been below NOAA Fisheries' recommended OY catch of 75% of MSY. Thus, it is expected that if present catch levels continue the stock will continue to remain healthy.

3.2.4.3.2 Habitat use by species in the Coastal Migratory Pelagic FMP

3.2.4.3.2.1 King mackerel habitat use

King mackerel occur in the Gulf of Mexico, with centers of distribution in south Florida and Louisiana. Adults are found over reefs and in coastal waters, although it rarely enters estuaries. Migrations to the northern Gulf in the spring are believed to be temperature dependent, and the species is found in waters > 20° C. While adults can be found at the shelf edge in depths to 200 m, they generally occur in < 80 m, at oceanic salinities from 32-36 ppt. Adults feed mostly on fishes, and less often on crustaceans and mollusks with a diet that includes jacks, snappers, grunts, halfbeaks, penaeid shrimp, and squid. Adult king mackerel are preyed upon by pelagic sharks, little tunny, dolphin, and bottlenose dolphin. Adults spawn over the outer continental shelf from May to October, with the northwestern and northeastern Gulf of Mexico considered important spawning areas. The pelagic eggs are found offshore over depths of 35-180 m in spring and summer. Larvae occur over the middle and outer continental shelf, principally in the north-central and northwestern Gulf, where they consume larval fishes such as carangids, clupeids, and engraulids. They are preyed upon by young pelagic fishes like tunas and dolphins. Juveniles are found from inshore to the middle shelf, where they feed on engraulid and clupeid fishes and some squid. Juveniles are preyed upon by larger pelagic fishes like little tunny and dolphin. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.13-3.2.16 and Appendix C.

For coastal pelagic species in eco-region 1, overall habitat use was highest for nearshore pelagic, offshore pelagic, offshore drift algae, estuarine pelagic, and nearshore reefs (Table 3.2.31). For species in eco-regions 2, 3, 4, and 5, overall habitat use was highest for nearshore pelagic, offshore pelagic, estuarine pelagic, offshore drift algae, and offshore shelf edge/slope (Table 3.2.31).

3.2.4.3.2.2 Spanish mackerel habitat use

Spanish mackerel occur in the Gulf of Mexico, with their center of distribution off Florida. Adults are found in inshore coastal waters, and may enter estuaries in pursuit of baitfish. Migrations to the northern Gulf in the spring are believed to be temperature dependent, and the species is found in waters > 20° C. and out to depths of 75 m at oceanic salinities. Adults feed mostly on fishes, and less often on crustaceans and mollusks with a diet that includes clupeids, engraulids, carangids, and squid. Adult Spanish mackerel are preyed upon by large pelagics like sharks and tunas, and also bottlenose dolphin. Adults spawn over the inner continental shelf from May to September, with the north-central and northeastern Gulf of Mexico considered important spawning areas. The pelagic eggs are found over the inner continental shelf at depths < 50 m in spring and summer. Larvae occur over the inner continental shelf, principally in the northern Gulf, where they consume larval fishes such as carangids, clupeids, and engraulids. They are preyed upon by young pelagic fishes like tunas and dolphins. Juveniles occur in estuarine and coastal waters, where they feed on engraulid and clupeid fishes, gastropods, and some squid. Juveniles are preyed upon by larger pelagic fishes like little tunny and dolphin. Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.13-3.2.16 and Appendix C.

3.2.4.3.2.3 Dolphin habitat use

Dolphin are found in offshore pelagic waters of the Gulf of Mexico. The 20° C. isotherm is thought to determine the northern limit of their distribution, and they are most abundant in waters ranging from 25-28°C at oceanic salinities. They are often found associated with *Sargassum* and other objects floating at the surface. Dolphin make seasonal north-south migrations. Adults feed on pelagic fishes such as carangids, scombrids, and flying fishes, and also crustaceans and cephalopods. They are preyed upon by large pelagic fishes like billfishes. Multiple spawning events occur throughout the year with various peaks in offshore, continental shelf and upper slope waters, principally at temperatures > 24 ° C. The pelagic eggs are found in the same areas, and the pelagic larvae are particularly abundant in waters offshore of the Mississippi River Delta. They are also commonly associated with *Sargassum* and feed on planktonic crustaceans and smaller fish larvae. Dolphin larvae are preyed upon by young billfishes. Juveniles are often found near *Sargassum* and other floating objects, and they feed on fishes, squid, and crustaceans. They are preyed upon by larger pelagic fishes, including other dolphin. Habitat associations are shown in Tables 3.2.13 and 3.2.14.

3.2.4.3.2.4 Little tunny habitat use

Little tunny are found in waters throughout the Gulf. It is a schooling species and can be found in both inshore and offshore waters of the Gulf of Mexico, and also in bays and over reefs. Adults feed on a variety of prey but mainly on fishes (e.g. round herring, spanish sardine, round scad) and squid. They are eaten by tuna, dolphin, billfishes, and sharks. Little tunny migrate northward in the spring. Spawning occurs in offshore waters from March through November. Early life history stages may utilize *Sargassum* in coastal waters as habitat. Little tunny juveniles are preyed upon by fast swimming pelagic fishes and seabirds.

3.2.4.3.2.5 Cero habitat use

In the Gulf of Mexico, cero are found principally off South Florida, especially in the area of the Florida Keys. Adults occur from mid-water to the surface over reefs, wrecks, ledges, and other underwater structures in depths from 1-20 m. They feed on fishes, particularly clupeids (especially herrings) and silversides, and also squid and shrimp. They are preyed upon by wahoo, sharks, dolphin (mammal), and young stages are eaten by seabirds. Spawning occurs offshore of the Florida coast in mid-summer. Unlike some of the other mackerel species, they do not migrate.

3.2.4.3.2.6 Bluefish habitat use

Bluefish are a schooling, migratory pelagic species occurring in estuaries, inshore waters, and over the continental shelf of the Gulf of Mexico. Adult bluefish are voracious, opportunistic predators consuming Atlantic croaker, striped mullet, menhaden, Spanish sardine, Atlantic bumper, round scad, portunid crabs, penaeid shrimp, squid, and gastropods. Spawning takes place from October-November in the northern Gulf of Mexico. Larvae presumably eat zooplankton, and juveniles are commonly found in estuaries feeding on anchovies, killifish, silversides, and small shrimp and crabs.

3.2.4.3.2.7 Cobia habitat use

In the Gulf of Mexico, cobia are found in coastal and offshore waters (from bays and inlets to the continental shelf) from depth of 1-70 m. Adults feed on fishes and crustaceans, including crabs. Spawning occurs in coastal waters from April through September at temperatures ranging from 23-28° C. These fish perform a seasonal migration, commonly seen among other species in the family. Eggs are found in the top meter of the water column, drifting with the currents. Larvae are typically found in offshore waters of the northern Gulf of Mexico, where they likely feed on zooplankton. Juveniles occur in coastal and offshore waters feeding on small fishes, squid, and shrimp. They may be preyed upon by dolphin (fish). Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages in the Gulf are presented in Tables 3.2.13-3.2.16 and Appendix C.

3.2.4.3.3 Prey and predators of species in the Coastal Migratory Pelagic FMU

Estuaries are important habitats for most of the major prey species of coastal pelagics (GMFMC 1985). For this reason estuarine habitats and factors which affect them should be considered as part of the coastal pelagic management unit. All the coastal pelagic species, except the dolphin, move from one area to another and seek as prey whatever local resources happen to be abundant. The coastal pelagics feed throughout the water column on a variety of fishes, especially herrings. Squid, shrimp, and other crustaceans are also eaten. Many of the prey species of the coastal pelagics are estuarine dependent in that they spend all or a portion of their lives in estuaries. Accordingly, the coastal pelagic species, by virtue of their food sources, are to some degree also dependent upon estuaries and, therefore, can be expected to be detrimentally affected if the productive capabilities of estuaries are greatly degraded.

Prey and predators of king mackerel, *Scomberomorus cavalla*
Prey:

Common Name	Taxa
Atlantic thread herring	*Opisthonema oglinum*
Scaled sardine	*Harengula jaguana*
Invertebrates (penaeid shrimp and squid)	Non-specific
Jacks	*Carangidae*
Snappers	*Lutjanidae*
Grunts	*Haemulidae*
Round scad	*Decapterus punctatus*
Spanish sardine	*Sardinella anchovia*
Gulf menhaden	*Brevoortia patronus*

Predators:

Common Species	Taxa
Bottle-nose dolphin	*Tursiops truncatus*
Tiger sharks	*Galeocerdo cuvier*
Bull sharks	*Carcharhinus leucas*
Smooth hammerhead	*Sphyrna zygaena*
Short-fin mako	*Isurus oxyrinchus*
Lemon shark	*Negaprion brevirostris*

Prey and predators of Spanish mackerel, *Scomberomorus maculatus*
Prey:

Common Name	Taxa
Herring	*Clupeidae*
False pilchard	*Harengula clupeola*
Shrimp	*Penaeus* spp.
Striped mullet	*Mugil cephalus*
Needlefish	*Strongylura* spp.
Anchovy	*Engraulidae*

Predators:

Common Name	Taxa
Dusky shark	*Carcharhinus obscurus*
Smooth hammerhead	*Sphyrna zygaena*
Bull shark	*Carcharhinus leucas*
Porbeagles	*Lamna nasus*
Tiger sharks	*Galeocerdo cuvier*

Prey and predators of cobia, *Rachycentron canadum*
Prey:

Common Name	Taxa
Mantis shrimp	*Squilla* spp.
Eels	non- specific
Crabs	non- specific
Squid	non- specific
Spanish mackerel	*Scomberomorus maculatus*

Predators: none have been determined so far

Prey and predators of cero, *Scomberomorus regalis*: They are thought to be very similar to that of the king and Spanish mackerel.

Prey and predators of Bluefish, *Pomatomas Saltatrix*:
Prey:

Common Name	Taxa
Butterfish	*Peprilus triacanthus*
Menhaden	*Brevoortia spp.*
Round herring	*Etrumeus teres*
Sand lance	*Ammodytes americanus*
Silverside	*Atherinidae*
Atlantic mackerel	*Scomber scombrus*
Anchovy	*Engraulidae*
Spanish sardine	*Sardinella anchovia*
Spotted seatrout (juveniles)	*Cynoscion nebulosus*

Common Name	Taxa
Atlantic croaker	*Micropogon undulatus*
Spot	*Leiostomus xanthurus*
Bay anchovy	*Anchoa mitchilli*
Squid	*Loligo pealei*

* They also eat the following invertebrates: shrimp, lobster, squid, crabs, mysids, and annelid worms

Predators:

Common Name	Taxa
Sand tiger	*Odontaspis taurus*
Thresher shark	*Alopias vulpinus*

* Sharks, tunas, swordfish and wahoo are the only potential predators that would pose a threat to the fast swimming bluefish.

Prey and predators of the little tunny. *Euthynnus alletteratus*

Prey:

Common Name	Taxa
Round herring	*Etrumeus teres*
Squid	non-specific
Spanish sardine	*Sardinella anchovia*
Round scad	*Decapterus punctatus*
Spanish mackerel	non-specific
Mud parrotfish	*Sparisoma flavascens*

* The only known predator of the little tunny is the bull shark.

Prey and predators of the dolphin, *Coryphaena hippurus*

Prey: the dolphin is an opportunistic species that will prey on most smaller fishes or squid which may be available. All of the dolphin's prey occur mainly in *Sargassum* communities

Predators:

Common Name	Taxa
Blue marlin	*Makaira nigricans*
Swordfish	*Xiphias gladius*
Whitetip shark	*Carcharhinus longimanus*

3.2.4.4 Shrimp FMU

3.2.4.4.1 Status of stocks

The Gulf of Mexico Fishery Management Council's Shrimp Stock Assessment Panel and SSC have proposed that the overfishing threshold be defined as a fishing mortality rate (F) that results in the parent stock number for the penaeid species being reduced below the following minimum levels:

> Brown Shrimp - 125 million individuals, age 7+ months during the November through February period.
>
> White Shrimp - 330 million individuals, age 7+ months during the May through August period.
>
> Pink Shrimp - 100 million individuals, age 5+ months during the July through June year.

Nance (2002) showed that over the last 32 years none of the parent stock numbers for these three species has ever been reduced to below these proposed levels. Consequently, the penaeid shrimp stocks in the Gulf are not undergoing overfishing. The overfished threshold is currently defined as an estimate of the parent stock number for the penaeid species that is below one-half of the overfishing definition as defined as follows:

> Brown Shrimp - 63 million individuals, age 7+ months during the November through February period.
>
> White Shrimp - 165 million individuals, age 7+ months during the May through August period.
>
> Pink Shrimp - 50 million individuals, age 5+ months during the July through June year.

Because these stocks have never experienced overfishing, under these defined levels for the overfished condition, they would also not be considered as overfished. MSY for royal red shrimp was currently set at 392,000 pounds. The fishery was close to harvesting this level in 1993-1994 with catches around 330,000 to 350,000 pounds. Catches declined thereafter through 1998, but have since increased to approximately 300,000 pounds in 2001. Because catches have never reached the MSY level and this level is considered to be conservative given that royal red shrimp are only fished by a small number of vessels over a small portion of their known biological range, this stock would not be considered as overfished or undergoing overfishing.

3.2.4.4.2 Habitat use by species in the Shrimp FMU

Brown, White, and Pink shrimp all spawn offshore in the Gulf of Mexico and produce demersal eggs, which hatch into pelagic larvae. The pelagic larvae of all three species consume planktonic algae and zooplankton (Darnell 1958; Perez-Farfante 1969). All three species migrate to estuaries as postlarvae. They all become benthic upon reaching their estuarine nursery grounds, growing and metamorphosizing to juveniles quickly in the food-rich estuarine environment (St. Amant et. al 1966). All three species are opportunistic feeders as juveniles and adults, consuming detrital organic matter, small invertebrates, small fishes, and plants (Darnell 1958; Perez-Farfante 1969). Predators of these three penaeid shrimp species include a number of fish species, blue crabs and seabirds. As they approach maturity, they emigrate from estuaries to offshore habitats. They also tend to move to deeper areas of the estuaries prior to making the emigration.

While the quantitative relationships between the various estuarine habitats and penaeid shrimp production are not known, information is available on the kind of environment necessary for shrimp survival (Idyll *et al*. 1967). Tidal marsh, particularly smooth cordgrass (*Spartina alterniflora*), provides important habitat for juvenile brown shrimp (Zimmerman *et al*. 1984). Submerged vegetation likewise is important shrimp habitat. Costello *et al*. (1986) found early juvenile pink shrimp in Florida Bay to be most abundant in shoal grass (*Halodule wrightii*) beds and less abundant in turtle grass (*Thallasia testudinum*). Clark *et al*. (1999) compared brown and white shrimp densities within microhabitats in several Texas estuaries using multiple regression analyses (GLM) to develop predictive models. They found that brown shrimp densities were predicted to be highest in high salinity (> 25 ppt) marsh edge and submerged aquatic vegetation microhabitats, as opposed to low salinity and shallow non-vegetated microhabitats. White shrimp densities were predicted to be highest in marsh edge microhabitats, but no significant relationship with salinity was found. Turner (1977) observed that the yield of shrimp in Louisiana's estuaries was directly related to the acreage of marsh, while that from the northeastern Gulf of Mexico was directly related to the acreage of marsh and submerged grassbeds. He found no relationship between yields and the amount of estuarine water surface, average water depth, or volume. His findings concur with the observations of Barrett and Gillespie (1973) that annual brown shrimp production in Louisiana is correlated with the acreage of marsh with water above 10 ppt salinity, but not with acres of estuarine water above 10 ppt salinity. These findings suggest that brown, white, and pink shrimp yields in the U.S. Gulf of Mexico depend on the survival of the estuarine marshes and grassbeds in their natural state. These areas not only provide postlarval, juvenile, and subadult shrimp with food and protection from predation, but they help to maintain an essential gradient between fresh and salt water.

The above focus on estuaries as important habitat for shrimp does not imply that offshore (i.e. marine) habitat is any less important. The estuaries are emphasized because (1) they are more vulnerable to degradation from a wider variety of human activities than is the marine environment and, (2) the estuarine phase of growth is considered the weakest link in the life cycle of shrimp.

Levels of habitat use in the Gulf of Mexico by Shrimp FMP species, calculated using the method described in Section 2.1.4.2.1 are depicted in Figures 3.2.14a and b. For shrimp species in eco-region 1, overall habitat use was highest for offshore sand/shell, offshore soft bottoms, and nearshore sand/shell (Table 3.2.32). For shrimp species in eco-region 2, overall habitat use was highest for nearshore sand/shell, nearshore soft bottoms, offshore sand/shell, nearshore pelagic, and offshore soft bottoms (Table 3.2.32). Although much of the area of the central West Florida Shelf (eco-regions 1 and 2) is classified as hard bottom in this EIS (Figure 3.1.3), it is actually a mosaic of interspersed hard bottom and sand/shell habitats, and as such provides some habitat for shrimp use. In eco-regions 3 and 5, highest overall habitat use was for offshore sand/shell, nearshore sand/shell, offshore soft bottoms, nearshore soft bottoms, and estuarine soft bottoms. In eco-region 4, overall habitat use by shrimp was highest for offshore soft bottoms, offshore sand/shell, nearshore soft bottoms, estuarine soft bottoms, and estuarine marshes (Table 3.2.32).

3.2.4.4.2.1 Brown shrimp

Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages of brown shrimp in the Gulf are presented in Tables 3.2.17-3.2.20 and Appendix C. Brown shrimp are found within estuaries to offshore depths of 110 m in the Gulf of Mexico, ranging mainly from Apalachicola Bay to the Yucatan Peninsula. Brown shrimp spawn in depths greater than 18m (Renfro and Brusher 1965) principally during the spring and summer when water temperatures are between 17 and 29 °C. Brown shrimp postlarvae migrate to estuaries through passes on flood tides at night, mainly from February-April, with a minor peak in the fall.

In estuaries, brown shrimp postlarvae and juveniles are associated with shallow vegetated habitats, but are also found over silty sand and non-vegetated mud bottoms, and have been collected in salinities ranging from 0-70 ppt. The density of late postlarvae and juveniles is highest in marsh edge habitat and submerged vegetation associated with decaying vegetation or organic matter (Williams 1955; Mock 1967; Jones 1973), followed by tidal creeks, inner marsh, shallow open water and oyster reefs; in unvegetated areas muddy substrates seem to be preferred. Clark *et al*. (1999) using multivariate analyses found that densities of juvenile brown shrimp were highest in high salinity (>25 ppt) marsh edge and submerged aquatic vegetation microhabitats in several Texas estuaries. Jones (1973), studying brown shrimp in Louisiana, saw a shift from deposit feeding among smaller shrimp to more active predation as they grew larger and began eating polychaetes, amphipods, nematodes, and chironomid larvae.

Sub-adult brown shrimp leave estuaries at night on an ebb tide during full and new moons (Copeland 1965). The particular stimulus causing the brown shrimp emigration is a matter of debate. Brown shrimp abundance offshore, correlates positively with turbidity and negatively with hypoxia. Adult brown shrimp occur in neritic Gulf waters (i.e., marine waters extending from mean low tide to the edge of the continental shelf) and are associated with silt, muddy sand and sandy substrates. Following their initial emigration from estuaries, they may continue a gradual migration to deeper Gulf waters (GMFMC 1981a).

3.2.4.4.2.2 White shrimp

Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages of white shrimp in the Gulf are presented in Tables 3.2.17-3.2.20 and Appendix C. White shrimp are found in estuaries and out to depths of 40 m (but usually < 27 m) from Florida's Big Bend through Texas. White shrimp spawn in depths between 9 and 34 m (but usually < 27 m) from spring through fall. In captivity, white shrimp have spawned at salinities and temperatures ranging from 26-34 ppt and 20-28 ° C. (Lawrence *et al*. 1980). White shrimp postlarvae enter estuaries through passes from May-November with peaks in June and September. White shrimp migration is in the upper two meters of the water column at night and at mid-depths during the day.

White shrimp postlarvae and juveniles inhabit mostly mud and peat bottoms with large amounts of decaying matter or vegetative cover, and they tend to be more active during the day than the other two species (Clark and Caillouet 1975). Juveniles have been reported to prefer lower salinity areas of estuaries (< 10 ppt), however, Clark *et al*. (1999) found no significant relation between juvenile white shrimp densities and salinity. They did, however, find significantly higher densities of juveniles in marsh edge microhabitats. Juvenile white shrimp were found to feed on sand, detritus, organic matter, mollusk fragments, ostracods, copepods, insect larvae, and forams (Darnell 1958).

Sub-adult white shrimp leave estuaries in late August and September on ebb tides during full moons (Whitaker 1982), and the timing appears to be related to shrimp size and environmental conditions (e.g. sharp temperature drops in fall and winter). Adult white shrimp inhabit nearshore Gulf waters to depths less than 30 m on bottoms of soft mud or silt.

3.2.4.4.2.3 Pink shrimp

Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages of pink shrimp in the Gulf are presented in Tables 3.2.17-3.2.20 and Appendix C. Pink shrimp occur in estuaries and to depths of 110 m (most abundant <50 m) and are the dominant shrimp species off South Florida. Pink shrimp spawn year-round in the Tortugas, but most intensively during spring through fall, at depths of 22-47 m (Ingle *et al*. 1959; Tabb *et al*. 1962) and temperatures between 19.6-30.6 ° C. (Jones *et al*. 1970). Off Tampa and Apalachicola Bays, spawning was most intense during the summer (Christmas and Etzold 1977). Pink shrimp postlarvae migrate into the estuaries at night, primarily during the spring and fall, usually on flood tides through passes or open shoreline.

Postlarval and juvenile pink shrimp are commonly found in seagrass habitats where they burrow into the substrate by day and emerge to feed at night. Pink shrimp densities are highest in or near seagrasses, low in mangroves, and near zero or absent in marshes. They tend to prefer calcareous-type sediments found most commonly in Florida and sand/shell mud mixtures (Springer and Bullis 1954; Williams 1958; Perez-Farfante 1969). Gut contents of juvenile pink shrimp have been found to contain macrophytes, red and blue-green algae, diatoms, dinoflagellates, polychaetes, nematodes, shrimp, mysids, copepods, isopods, amphipods, mollusks, forams, and fish (Eldred *et al*. 1961).

In the Everglades, Yokel *et al*. (1969) found that pink shrimp emigrated from the estuary mainly at night on ebb tides and more intensively during new and full moons. Adult pink shrimp are most abundant in Gulf waters from 9-48 m deep on coarse mixtures of sand and shell with less than 1% organic material. More detailed discussions of brown, white and pink shrimp habitat associations are provided in Nelson (1992) and Pattillo *et al*. (1997).

3.2.4.4.2.4 Royal red shrimp

Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages of royal red shrimp in the Gulf are presented in Tables 3.2.17-3.2.20 and Appendix C. Royal red shrimp are also in the management unit of the FMP. This species differs from the penaeid species in that, it is not estuarine dependent, spends its entire life cycle in open Gulf waters, may have up to five year classes occurring together, and lives in a relatively stable environment. In addition, no individuals mature during year-0. The species is known to occur from Martha's Vineyard (Massachusetts) through the Gulf of Mexico and the Caribbean Sea to French Guiana, where they live on the upper continental shelf at depths between 180 and 730 m. Royal Reds are scarce in less than 250 m and not abundant at depths greater than 500 m. The highest concentration has been reported in the northeastern part of the Gulf of Mexico at depths between 250 and 475 m. Off St. Augustine, spawning is believed to occur from winter through spring (Anderson and Lindner 1971). Data on the larvae are unknown. Commercial concentrations of royal red shrimp have been reported on the following types of bottoms: blue-black terrigenous silt and silty sand off the Mississippi River Delta; and whitish, gritty, calcareous mud off the Dry Tortugas (Roe 1969; GMFMC 1996).

3.2.4.4.3 Prey species used by Shrimp FMU species

Larvae of shrimp feed on phytoplankton and zooplankton. Postlarvae feed on epiphytes phytoplankton, and detritus. Juveniles and adults prey on polychaetes, amphipods and chironomid larvae but also detritus and algae. The habitat of these prey is essentially the same as required by shrimp (GMFMC 1981a).

Prey and predators of species in the Shrimp FMU

Common Name	Taxa	Prey
Brown shrimp	*Farfantepenaeus aztecus (Penaeus aztecus)*	Polychaetes, amphipods, nematodes, and chronomid larvae
White shrimp	*Litopenaeus setiferus (Penaeus setiferus)*	Fragments of mollusks, ostracods, copepods, insect larvae, and forams
Pink shrimp	*Farfantepenaeus duorarum (Penaeus duorarum)*	Dinoflagellates, polychaetes, nematodes, shrimp, mysids, copepods, isopods, amphipods, mollusks, forams, and fish
Royal red shrimp	*Hymenopenaeus robustus*	no information available
Seabobs	*Xiphopeneus kroyleri*	no information available

Common Name	Taxa	Prey
Rock shrimp	*Sicyonia brevirostris*	small bivalve mollusks, decopod crustaceans, gastropods, foraminifora, nematodes, polychaetes, ectoprocts, echinoderms, and finfish

Fish identified as feeding on Penaeid shrimp:

Common name	Taxa
Sand seatrout	*Cynoscion arenarius*
Silver seatrout	*Cynoscion nothus*
Spotted seatrout	*Cynoscion nebulosus*
Atlantic croaker	*Micropogon undulatus*
Inshore lizardfish	*Synodus foetens*
Rock sea bass	*Centropristis philadelphica*
Ocellated flounder	*Ancylopsetta quadrocellata*
Dwarf sand perch	*Diplectrum bivattum*
Lane snapper	*Lutjanus synagris*
Smooth puffer	*Lagocephalus laevigatus*
Bighead searobin	*Prionotus tribulus*
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*
Spanish mackerel	*Scomberomorus maculatus*
Red snapper	*Lutjanus campechanus*

3.2.4.5 Stone Crab FMU

3.2.4.5.1 Status of stocks

Although stone crabs occur throughout the Gulf of Mexico, the majority of fishing occurs along the Gulf coast of Florida. The majority of landings have been reported almost exclusively (98% by weight) in Gulf coast counties. Significant landings were reported in all counties south from Wakulla County on the Gulf coast of Florida in 2000.

A stock assessment for this fishery was performed in 1997 by Muller and Bert, which was recently updated in 2001 (Muller and Bert 2001). The stone crab is a unique fishery since stone crabs are not killed but rather the claws (one per crab) are removed and the crabs are returned alive to the water. Crabs that survive declawing can regenerate claws through molting allowing new claws to be harvested. The biological linkage between landings of claws and the underlying stock of crabs has not been fully assessed due to the lack of a state-wide, fishery-independent sampling program (Muller and Bert 2001). However, stock estimates have been made by examining relationships between claw landings and catch per unit effort (CPUE) data.

Overall, stone crab claw landings have been increasing since the early 1960s, although landings have leveled off during the 1990s. An unusual decline in landings in the 1984-85 season was hypothesized to be due to an increase in octopus (a predator of stone crabs) populations (Lindberg *et al*. 1989). In calendar year 2000, commercial stone crab landings in Florida totaled 6,876,098 pounds (estimated body weight) or 3.44 million pounds of claws. Estimates for the size of the recreational fishery are currently unknown. The number of commercial traps in the fishery has increased from 14,000 in 1962-63 to an estimated 1.4 million in 1998-99.

Effort also has increased during the past 38 years and has leveled off during the 1980s and 1990s. The number of commercial trips has increased from 19,000 per season in 1985-86 (the first season with trip information available) to a maximum of 37,000 trips in the 1996-97 season. Using this data, the fishery appears to be fully exploited, yet the stock seems to be sufficient to maintain recruitment levels (Muller and Bert 2001). This is evidenced by the fact that landings have been level for the past decade even though the number of traps in the fishery has doubled. In response to the apparent excess number of permitted traps, a trap reduction program has been developed by the State of Florida. The final rule for Gulf stone crab Amendment 7 (trap limitation program to complement FL's program) became effective on November 4, 2002.

In their previous assessment, Muller and Bert (1997) noted that the catch rates of juvenile crabs from a fishery independent stone crab monitoring project in Tampa Bay provide a good estimate of the local commercial fishery's catch rates (i.e. stocks) three years later. The juvenile index in Tampa Bay has increased every year since a low point in 1996-97. If juvenile catch rates from the monitoring program continue to predict future commercial catch rates, then commercial catch rates should increase for the next three seasons. If this relationship holds in other areas of Florida, fishery independent sampling has the potential to serve as an early warning system for the stone crab fishery.

3.2.4.5.2 Habitat use by species in the Stone Crab FMU

Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages of stone crab species in the Gulf are presented in Tables 3.2.21-3.2.24 and Appendix C. Stone crabs are found from North Carolina south around peninsular Florida to the Yucatan and Belize. They are also found throughout the Bahamas and Greater Antilles. Florida stone crab, *Menippe mercenaria*, and gulf stone crab, *M. adina* comprise the stone crab fishery in the Gulf of Mexico. The Gulf stone crab is typically smaller than *M. mercenaria* and replaces the Florida stone crab in the northern and western Gulf of Mexico (northwest Florida to Tamaulipas, Mexico). Zones of secondary contact and hybridization occur between the two species in the Gulf between Cedar Key and Cape San Blas, and in the Atlantic between Cape Canaveral and Charleston, South Carolina (Bert and Harrison 1988).

Adult stone crabs are benthic organisms and can be found from the shoreline out to depths of 61 m. They occupy a variety of habitats including burrows under rock ledges, coral heads, dead shell, or seagrass patches. Adults also inhabit oyster bars and rock jetties and are commonly found on artificial reefs where adequate refugia are present. Florida stone crabs spawn principally from April through September, although some spawning occurs all year (FMRI 2001).

Juveniles (less than 30 mm carapace width, CW) are also benthic dwellers but do not burrow; they use readily available refugia in close proximity to food items. Juveniles can be found on shell bottom, sponges, and *Sargassum* mats as well as in channels and deep grass flats. After reaching a width of about 0.5 in. (12.5 mm), the crabs live within oyster beds and rocks in shallow parts of estuaries. There are numerous reports of large juveniles - small adults (up to 60 mm CW) being abundant on oyster reefs (FMRI 2001). Adults and juveniles appear to be hardy and can tolerate most environmental extremes within their distribution range and are capable of surviving salinities considerably higher or lower than 33 ppt.

Stone crab larvae are planktonic and require warm water 30^{o} C (86^{o} F) and high salinity (30-35 ppt) for most rapid growth. Larval survival and growth rates decline rapidly below 25^{o} C (77^{o} F) and 25 ppt (FMRI 2001). In certain broad areas of shallow water such as upper Florida Bay, larvae may have high mortality rates due to dramatic fluctuations in salinity and temperature. Previous reports by FMRI (2001) indicate three recruitment areas for post-settlement juveniles: the Cedar Key area, the Tampa Bay area, and the nearshore waters off of Ten Thousand Islands north of Cape Sable. Small juveniles are rare or absent from Florida Bay, upper Tampa Bay and estuaries north of Cedar Key. Larger juveniles are found in the nearshore waters of west Florida and are most abundant within these recruitment areas. They are not found in Florida Bay and are rare in upper Tampa Bay and upper Charlotte Harbor.

The most productive habitat for stone crabs is reported to occur in the Everglades - Florida Bay area (FMRI 2001). Stone crabs are caught in shallow Florida Bay and offshore from Cape Sable to Cape Romano out to a water depth of 15 to 18 m. The shoreline in this area is comprised of fringing mangrove swamp and extensive oyster reefs in the Ten Thousand Islands area and as turtle grass flats from Cape Sable northward to Cape Romano Shoals. In the area of Cape Romano Shoals, flocculent sand and mud bottom conditions preclude extensive commercial fishing. The offshore areas along the west coast of Florida are comprised of turtle grass out to depths between 6 to 9 m. Hard packed sand with scattered shell and patches of hard bottom with attached soft coral and sponge communities occur beyond these seagrass meadows and serve as stone crab habitat.

Levels of habitat use in the Gulf of Mexico by Stone Crab FMP species, calculated according to the method described in Section 2.1.4.2.1, are depicted in Figures 3.2.15a and b. For stone crab in eco-region 1, overall habitat use was highest for estuarine hard bottoms, estuarine sand/shell, estuarine SAV, nearshore hard bottoms, nearshore sand/shell, and nearshore SAV (Table 3.2.33). In eco-region 2, overall habitat use was highest for estuarine sand/shell, nearshore sand/shell, estuarine hard bottoms, estuarine soft bottoms, estuarine SAV, nearshore hard bottoms, and nearshore SAV (Table 3.2.33).

3.2.4.5.3 Prey species used by Stone Crab FMU species

The stone crab is a high trophic level predator and is primarily carnivorous at all life stages. Juveniles feed on small molluscs, polychaetes and crustaceans. Adults consume several species of mollusks, including oysters and mussels, and also consume carrion and vegetable matter such as seagrass (Lindberg and Marshall 1984).

The stone crab population is basically dependent upon the prey produced in the estuaries and seagrass beds that abound along the Florida west coast (GMFMC 1994). Nutrient rich, freshwater runoff flowing into the estuaries fertilizes the seawater, resulting in high seagrass and phytoplankton productivity. Lower salinity (which can often exclude predators) and plentiful phytoplankton are ideal for oysters, worms, and other organisms. These provide abundant food and shelter for juveniles and adult stone crabs. Seagrasses and mangrove forests, often the dominant features in nearshore and estuarine environments, and the epiphytic algae on them are generally considered to be the major producers of organic matter in coastal ecosystems. They provide protective covering and, along with the phytoplankton in the surrounding water, support the food items of the stone crab.

Prey and predators of species in the Stone Crab FMU

Prey:

Stone crab life stage	Common Name
Larvae	Zooplankton
	Phytoplankton
	Brine Shrimp
Juveniles	Polychaetes
	Flatworms
	Small bivalves
	Oyster drills
	Other stone crabs
	Seagrass blades
	Epiphytic and epizoic organisms that grow on the blades and carrion
Adults	Mollusks
	Other stone crabs
	Carrion

Predators:

Stone crab life stage	Common Name	Taxa
Larvae	Red drum	*Sciaenops ocellatus*
	Goliath grouper	*Epinephelus itajara*
Juveniles	Large groupers	Serranidae
	Black sea bass	*Centropristis striata*

Stone crab life stage	Common Name	Taxa
	Oyster conch	*Thais floridana*
	Other stone crabs	*Mercenaria* spp.
Adult	Large grouper	Serranidae
	Black sea bass	*Centropristis striata*
	Horse conch	*Pleuroploca gigantea*
	Sea turtles	
	Octopods	
	Other stone crabs	*Mercenaria* spp.
	Cobia	*Rachycentron canadum*
	Goliath grouper	*Epinephelus itajara*

3.2.4.6 Spiny Lobster FMU

3.2.4.6.1 Status of stocks

The spiny lobster fishery is managed throughout its range from North Carolina through Texas. The commercial fishery and a large proportion of the recreational fishery occur in waters offshore of south Florida, primarily off Monroe County, Florida in the Florida Keys. The percentage of the fishery in this region of Florida comprised approximately 96 percent of all landings in 1984 (GMFMC and SAFMC 1990).

According to the 1982 Fishery Management Plan, and subsequent Amendments, the true abundance of spiny lobster in Florida is unknown. Lyons (1986) reviewed several hypotheses about the source of recruitment to the south Florida spiny lobster fishery including pan-Caribbean, local south Florida, and Gulf of Mexico sources. At this point it has not been determined which of these recruitment scenarios is correct or the proportion of recruitment that comes from inside and outside the south Florida area.

Gregory *et al*. (1982) suggest that relative abundance in spiny lobster populations is indicated by catch and catch per unit effort and that these data should be adjusted for catches from areas outside Florida (Bahamas, other foreign waters). A surplus yield model described in the 1982 GMFMC and SAFMC Fishery Management Plan for spiny lobster was originally used to assess the maximum sustainable yield of the stock. Using recorded catch and effort data for the commercial trap fishery in the primary fishing areas estimates of sustainable yield for spiny lobster was 5.9 million pounds with a 3.0 inch carapace length minimum size limit. The maximum sustainable yield was estimated at 12.7 million pounds.

Since about 1970, the commercial landings of spiny lobster in Florida have varied without trend between 4.3 million pounds and 7.9 million pounds per fishing season (FMRI 2001). During the 2000 calendar year, the commercial fishery landed 5,754,983 pounds in Florida with 90% of these landings made on the Gulf coast. Commercial landings were concentrated in South Florida in Monroe and Dade Counties.

The FMP (1981), Amendment 1 (1987), and Amendment 2 (1989) for spiny lobster describe the fishery, changes in the fishery and utilization patterns and the condition of the stock. According to recent data, the stock has been relatively stable over the past several decades and no recruitment overfishing is occurring, despite heavy commercial and recreational fishing pressure. A trap reduction program has since been implemented to address overfishing effects.

A more recent stock assessment was performed by FMRI (Muller *et al*. 2000) for the Florida Keys area. For this assessment, commercial and recreational landings were updated through the 1999-2000 fishing season. Landings were combined with lengths and sexes to estimate the number of lobsters landed by ages and season. Catch-at-age data were analyzed together with indices of abundance using the same age-structured, separable virtual population method that was used in previous assessments described above, to estimate population sizes, fishing mortality rates, and recruitment trends.

Based on this updated modelling and data analysis effort, it was determined that the lobster fishery continues to fluctuate without trend as it has done for the last 30 years. Landings increased in the 2000 season after a decline in the 1998-99 season. The evidence indicates that lobster biomass in the Florida Keys is increasing although the overall average fishing mortality rates after the Trap Reduction Program have been similar to those from before the program. A possible explanation for the increase in the fishable population may be related to a decrease in the use of sub-legal lobsters to bait traps.

3.2.4.6.2 Habitat use by species in the Spiny Lobster FMU

Information on habitat associations, depth ranges, geographical distribution, and other characteristics of different life stages of spiny lobster species in the Gulf are presented in Tables 3.2.25-3.2.28 and Appendix C. The principal habitat used by spiny lobster is offshore coral reefs and seagrasses (GMFMC and SAFMC 1989) to depths of 80 m or more. The Florida Platform is fronted by shelf-edge reef complexes of the Cretaceous Era. The Southwest Florida Reef Tract appears to be the most important feature for spiny lobster. The benthos in this area is composed of sand and shell inshore and coral-sponge farther offshore. Temperature and salinity are typically high throughout most of the year and are generally higher than areas to the north of Tampa. Areas of high relief on the continental shelf serve as spiny lobster habitat and include coral reefs, artificial reefs, rocky hard bottom substrates, ledges and caves, sloping soft-bottom areas, and limestone outcroppings.

Spiny lobster spawn in offshore waters along the deeper reef fringes (Lyons *et al*. 1981). Adult males and females occasionally inhabit bays, lagoons, estuaries, and shallow banks, however, they are not known to spawn in these shallower areas (Marx and Herrnkind 1986). Their requirements for offshore spawning habitat are: high shelter quality, suitable water conditions (stable temperature and salinity, low surge and turbidity), and adequate larval transport by oceanic currents (Kanciruk and Herrnkind 1976; Marx and Herrnkind 1986).

Detailed habitat requirements for the various spiny lobster life stages are taken from the following excerpt by Marx and Herrnkind (1986):

> "Phyllosoma larvae inhabit the epipelagic zones of the open ocean, which are characterized by relatively constant temperature and salinity, low levels of suspended sediments, and few pollutants. Relatively stable, natural conditions are apparently required for optimum survival. Ingle and Whitham (1968) noted that "spiny lobster larvae are extremely delicate, physically, and inordinately fastidious, physiologically". Larvae are particularly sensitive to silt particles, which can, in extreme instances, lodge on their setae, weigh them down, and cause death (Crawford and De Smidt 1922). Because nutritional requirements change throughout the life of the larvae (Provenzano 1968; Phillips and Sastry 1980), enhanced growth and survival require a diverse, productive oceanic plankton community. Positive correlations between plankton biomass and density of late-stage phyllosomes were reported by Ritz (1972). Although pueruli settle on isolated oceanic banks where the minimum depth exceeds 10 m (Munro 1974), productive fisheries apparently require well-vegetated shallow habitat for juvenile development. Biscayne Bay and Florida Bay are critical nurseries for Florida lobsters (Davis and Dodrill 1980). These bays are characterized by extensive meadows of benthic vegetation, primarily turtle grass (*Thalassia testudinum*), shoal grass (*Halodule wrightii*), and various algae (Tabb *et al*. 1962; Hudson *et al*. 1970; Eldred *et al*. 1972). Macroalgal communities interspersed among these areas apparently are important for the earliest benthic stages. Red algae, *Laurencia* spp., are abundant in waters supporting concentrations of young juveniles (Eldred *et al*. 1972; Andree 1981; Marx 1983). Intricate algal branching provides young lobsters with cryptic shelter and supports a diverse assemblage of small gastropods, crustaceans, and other prey.
>
> "Juveniles larger than 20 mm CL take refuge in both biotic (sponges, small coral heads, sea urchins) and abiotic (ledges, solution holes) structures. The importance of shelter availability on population distribution is magnified because, unlike clawed lobster, spiny lobsters can modify but not construct dens (Kanciruk 1980). Substantial addition of artificial shelters in Biscayne Bay caused population redistribution but did not increase the numbers of lobsters in the area (Davis 1979). The south Florida juvenile lobster population may be limited by recruitment, emigration, food, and perhaps other factors (Davis 1979).
>
> "Adults inhabit coral reef crevices or overhangs, rocky outcroppings, ledges, and other discontinuities in hard substrate. Residential patterns of habitation are apparent in large, permanent dwellings near extensive feeding grounds (Herrnkind *et al*. 1975). Soft-substrate shelters, like grass-bed ledges, are occupied primarily during nomadic movements. Muddy, turbidity-prone substrates are usually avoided (Herrnkind *et al*. 1975; Kanciruk 1980).

> "Throughout benthic life spiny lobsters use other habitats besides those providing shelter. Lobsters concentrated during the day in localized dens disperse at night to forage over adjacent grass beds, sand flats, and algal plains (Herrnkind *et al*. 1975). Interactions between population density of spiny lobster and food availability have not been studied in south Florida. Extreme variation in growth rates, both among individuals and by habitat, suggests that food abundance is a critical factor, as demonstrated in spiny lobster species elsewhere (Chittleborough 1976)."

Reproductive adults are primarily found along the oceanic (eastward) and gulfward (west) reef and hard substrate fringes of the Keys and Florida Bay. Some individuals may move back and forth to the bay during non-reproductive periods. Juveniles above 20 mm CL are abundant but scattered throughout middle and lower Florida Bay wherever benthic conditions provide refuge. The larger juveniles wander over all intervening habitats and feed extensively in vegetated substrates; they make up the bulk of animals captured in traps within the bay. The distribution and abundance of young juveniles between settlement and 20 mm CL are yet to be quantitatively estimated. Based on recent ecological studies (Marx and Herrnkind 1985; Herrnkind and Butler 1986; Herrnkind *et al*. 1988), it is likely that settlement occurs wherever swimming postlarvae are brought into contact with inshore stands of benthic algae and other fouling assemblages. Each hectare (10,000 m^2) of red algal meadow is calculated to nurture 1,000 juvenile lobsters annually as new settlers continually recruit monthly, then grow and emigrate to other habitats after several months (Marx 1986). Slightly older individuals can be reliably found in mixed substrates within and adjacent to such areas. Upon outgrowing the algal habitat, the young juveniles take on an increasingly nomadic lifestyle as they gain locomotory proficiency.

Levels of habitat use in the Gulf of Mexico by Spiny Lobster FMP species, calculated according to the method described in Section 2.1.4.2.1 are depicted in Figures 3.2.16. For spiny lobster species in eco-region 1, overall habitat use was highest for offshore reefs, estuarine SAV, nearshore SAV, nearshore hard bottoms, and nearshore reefs (Table 3.2.34). In eco-regions 2, 3, 4, and 5, only larvae are present, and the only habitat considered to be utilized was offshore pelagic (Table 3.2.34).

3.2.4.6.3 Prey and predators of species in the Spiny Lobster FMU species

The feeding and food items of spiny lobster are summarized in Pattillo *et al*. (1997). Spiny lobster phyllosomes presumably feed on plankton. Benthic postlarvae are opportunistic feeders, consuming a large variety of organisms including small gastropods, bivalves and crustaceans. Young juveniles feed on molluscs, crustaceans and other fauna that exist on the algal clumps in which they reside. Large juveniles and adults are higher carnivores, feeding on algae, foraminifera, sponge spicules, polychaetes, bivalves, conchs, hermit crabs, and other crustaceans. Habitat of the prey species is essentially the same as habitat required by spiny lobster (GMFMC and SAFMC 1990).

Prey species of the Spiny Lobster, *Panulirus argus:*

Spiny lobster lifestage	Common Names of Prey Species
Larvae	small planktonic crustacean larvae
Young juveniles	Mollusks
Large juveniles & adults	algae, foraminifora, sponge spicules, polychaetes, bivalve remains, gastropod mollusk remains, and crustacean remains, fish, crustaceans (including other lobsters) mollusks particularly the turkey wing clam

Common predators of the Spiny Lobster:

Predator Common Name	Taxa
Tuna	*Katsuwonus pelamis*
Tuna	*Thunnus atlanticus*
Stingray	*Dasyatis* spp.
Nurse shark	*Ginglymostoma cirratum*
Snappers	*Lutjanus* spp.
Grouper	*Mycteroperca* spp.
Grouper	*Epinephelus* spp.
Octopods	
Dolphins	*Tursiops* spp.
Loggerhead turtles	*Caretta caretta*
Apple murex	*Phyllonotus pomum*

3.2.4.7 Coral FMU

3.2.4.7.1 Status of Stocks

Because collection of stony corals (Scleractinians) and sea fans (Gorgonacea) is prohibited in U.S. waters of the Gulf of Mexico, harvest is minimal and the majority of collections are for research purposes. NOAA Fisheries reports a commercial harvest of 0 tons from Gulf waters between 1992 and 2000, the last year for which data are available. Thus, corals are generally considered a non-consumptive resource.

Because coral reef habitat is limited in U.S. waters, protective measures have been enacted to preserve U.S. coral reefs by declaring certain areas as sanctuaries and restricting oil and gas activities within these areas. In June 1990, President George Bush declared a ten-year ban on offshore drilling near the Florida Keys, which was then extended an additional ten years by President Bill Clinton. In 1989, Florida shut down its coral harvesting industry to protect its reefs. Florida has taken further protective measures including licensing collectors, setting catch limits, and ticketing tourists who engage in activities abusive to sanctuary corals including anchoring in coral, spear fishing, and hanging on to coral while scuba diving.

3.2.4.7.2 Habitat Use by Species in the Coral FMU

Coral larval development in broadcast-spawners is planktonic, and can last anywhere from three days to more than six weeks lending support to the hypothesis that reefs may be dependent upon other reefs positioned upstream, which act as larval source points (Harrison *et al.*, 1984; Williams *et al.*, 1984; Willis *et al.*, 1985; Babcock and Heyward, 1986; Bull, 1986; Wallace *et al.*, 1986; Oliver and Willis, 1987; Willis and Oliver, 1988; Roberts, 1997). Long-distance dispersal hypothesis of planktonic larvae proposed by Dana (1975) to explain the origins of the Eastern Pacific coral fauna, has long been the favored hypothesis explaining the wide geographic distributions of many tropical marine coral reef species (Pulley, 1963; Scheltema, 1971, 1986a,b; Sale, 1980; Jokiel, 1984; Richmond, 1987; Scheltema *et al.*, 1996; Benzie and Williams, 1997; Roberts, 1997).

More recently, localized retention of planktonic larvae has received greater attention and acquired a more significance role in consideration of reef population dynamics. Both hydrographic modeling and current flow measurements indicate that larval retention occurs, and that its magnitude is influenced by the size and morphology of the island/reef mass and current velocity (Emery, 1972; Hamner and Hauri, 1981; Williams *et al.*, 1984; Leis, 1986; Lobel and Robinson, 1986; Hamner and Wolanski, 1988; Farmer and Berg, 1990; Black *et al.*, 1990, 1991; Boehlert *et al.*, 1992; Black, 1993; Boehlert and Mundy, 1993; Cowen and Castro, 1994; Schultz and Cowen, 1994).

Coral spawning activity in the Gulf is highly synchronous within species populations, and produces viable offspring that are capable of, and in fact must, sustain the Gulf of Mexico reefs. The physical oceanographic mechanisms in place that enable this are large-scale, possibly transient, circulation features (Beaver *et al*. in press). Dispersal of planktonic larvae between northern Caribbean and western Gulf reefs does occur, as evidenced by the overall lack of genetic divergence among these populations (Hagman, 2000). However, while the frequency of this exchange remains unclear, its overall contribution to the maintenance of the Flower Gardens coral reefs appears negligible. Ultimately however, ascertaining the true importance of the degree of connectivity or isolation among the Flower Gardens and other reefs will require a more detailed investigation of annual recruitment patterns, and potential signatures of dispersal (Hagman, 2000)

Primary reef building occurs at the Flower Garden Banks, Florida Middle Grounds and Dry Tortugas. These are described in more detail in the following sections. Other zones of negligible reef building occur across the Texas-Louisiana shelf. These areas typically occur outside the parameters required for substantial reef growth; however, some carbonate deposition occurs, creating relief above the shifting mud bottom that permits attachment of sessile organisms, creating diverse reef communities

A deepwater reef in the Gulf of Mexico was discovered in the 1950s approximately 74 km east of the Mississippi River Delta (Moore and Bullis 1960). This reef was largely composed of *Lophelia prolifera* in water depths of 420-512 m. The largest portion of the reef is about 55 m thick and over 305 m long. Two smaller portions are over 100 m across and up to 18 m thick. The entire reef is more than 1,200 m in length across.

3.2.4.7.2.1 The Flower Garden Bank

The Flower Garden Banks are the northernmost coral reefs in the United States, located about 105 miles directly south of the Texas/Louisiana border (Bright *et al*. 1985). The Flower Gardens is a low diversity, high cover, coral reef community perched atop two salt domes protruding to within 20 m of the surface from the surrounding depths.

The reef supports 21 species of corals, 80 species of algae, over 250 marine invertebrates and more than 200 species of fish. Additionally, 3 species of endangered sea turtles have been documented on the reef. Conspicuously absent from the Flower Gardens are large branching corals, and sea fans.

The Flower Garden Banks are located on the edge of the outer continental shelf of the Gulf of Mexico. The East Flower Garden Bank located at 27°54.5' North latitude and 93°36.0' West longitude is approximately 193 km southeast of Galveston, Texas, and the West Flower Garden Bank is located approximately 172 km southeast of Galveston at 27°52.4' North latitude and 93°48.8' West longitude. The coral cap varies in depth from approximately 18 to 36 m. (Rezak *et al*. 1985).

The nearest tropical coral reefs to the Flower Gardens are 400 miles away off Tampico, Mexico. Scientists believe that corals at the Flower Gardens probably originated from Mexican reefs when currents in the western Gulf of Mexico carried the young corals (planulae), other animal larvae, and plant spores northward. In 1992, the banks were designated a National Marine Sanctuary. In October 1996, Congress expanded the Sanctuary by adding a small third bank. Stetson Bank is also a salt dome, located about 70 miles south of Galveston, Texas. Because of its location, average temperatures during the winter are several degrees cooler than at the Flower Gardens. Consequently, the corals do not thrive and build into reefs. Instead, this bank supports a coral/sponge habitat and rich assemblages of associated animals and plants where the siltstone bedrock can still be seen in many places.

Zonation of the Flower Garden Banks as described by Bright *et al*. (1985) follows:

Diploria-Montastraea-Porites Zone
This zone is characterized by 18-20 hermatypic coral species and is found predominantly at the East and West Flower Garden Banks. The dominant species/groups of the zone in order of dominance are the *Montastraea annularis complex* (this group includes *M. franksii*, *M. faveolata*, and *M. annularis*), *Diploria strigosa*, *Porites asteroides*, *Colpophyllia natans*, and *Montastraea cavernosa* (Dokken *et al*., in preparation). Coralline algae are abundant in areas, which adds substantial amounts of calcium carbonate to the substrate. In addition to the coralline algae, there is a considerable amount of bare reef rock, which fluctuates in percent cover with the appearance of a red, turf-like algae at both banks. Red turf algae (Order Ceramiales) is the dominant algal group at the East and West Flower Garden Banks and has increased in percent cover substantially over the last several years. Dokken *et al*. (2002) reported algal percent cover at both banks was significantly greater during 1999 than 1998. Percent coral cover in this zone is

estimated at 59.0 percent and 54.6 percent at the East and West Banks, respectively (Dokken *et al*. 2002).

Typical sport and commercial fish observed in this zone include various grouper species, amberjack, barracuda; red, gray, and vermilion snapper; cottonwick; and porgy. There is also a diverse group of tropical reef fish species found on these banks, including creole fish; queen, stoplight, red band, and princess parrot fish; rock beauty; blue tang, and the whitespotted filefish, just to name a few. There are over 175 tropical reef species that reside within the high-diversity zone at the Flower Garden Banks (Dennis and Bright 1988; Pattengill 1998). This high-diversity *Diploria/Montastraea/Porites* Zone is found only at the East and West Flower Garden Banks in water depths less than 36 m.

Madracis and Fleshy Algal Zone
The *Madracis* Zone is dominated by the small branching coral *Madracis mirabilis*, which produces large amounts of carbonate sediment. In places, large (possibly ephemeral) populations of turf-like algae dominate the *Madracis* gravel substratum (Algal Zone). The *Madracis* Zone appears to have a successional relationship with the *Diploria-Montastraea-Porites* Zone. *Madracis* colony remains build up the substrate and allow the successional species to grow. The zone occurs at the East and West Flower Garden Banks between 28 and 46 m.

Stephanocoenia-Millepora Zone
The *Stephanocoenia-Millepora* Zone is inhabited by a low-diversity coral assemblage of 12 hermatypic corals and can be found at the Flower Garden, McGrail, and Bright Banks. The eight most conspicuous corals in order of dominance are *Stephanocoenia michelinii*, *Millepora alcicornis*, *Montastraea cavernosa*, *Colpophyllia natans*, *Diploria strigosa*, *Agaricia agaricites*, *Mussa angulosa*, and *Scolymia cubensis*. The assemblages associated with this zone are not well known; coralline algae is the most conspicuous organism in the zone. Additionally, reef fish populations are less diverse; but the Atlantic spiny oyster (*Spondylus americanus*) appears numerous. The depth range of this zone is between 36 and 52 m.

Algal-Sponge Zone
The Algal-Sponge Zone covers the largest area among the reef-building zones. The dominant organisms of the zone are the coralline algae, which are the most important carbonate-nodule producers. The alga nodules range from 1 to 10 cm in size, cover 50-80 percent of the bottom, and generally occur between 55 and 85 m. The habitat created by the alga nodules supports communities that are probably as diverse as the coral-reef communities. Most of the leafy algae found on the banks occur in this zone and contribute large amounts of food to the surrounding communities. Calcareous green algae (*Halimeda* and *Udotea)* and several species of hermatypic corals are major contributors to the substrate. Deepwater alcyonarians are abundant in the lower Algal-Sponge Zone. Sponges, especially *Neofibularia nolitangere,* are conspicuous. Echinoderms are abundant and also add to the carbonate substrate. Small gastropods and pelecypods are also abundant. Gastropod shells are known to form the center of some of the algal nodules. Characteristic fish of the zone are yellowtail reeffish, sand tilefish, cherubfish, and orangeback bass.

Partly drowned reefs are a major biotope of the Algal-Sponge Zone. These are reefal structures covered with living crusts of coralline algae with occasional boulders of hermatypic corals. In addition to the organisms typical to the rest of the Algal-Sponge Zone, the partly drowned reefs are also inhabited by large anemones, large comatulid crinoids, basket stars, limited crusts of *Millepora*, and infrequent small colonies of other hermatypic species. The relief and habitat provided by the carbonate structures also attract a variety of fish species, especially yellowtail reeffish and blue and queen angelfish.

Millepora-Sponge Zone
The *Millepora*-Sponge Zone occupies depths comparable to the *Diploria-Montastraea-Porites* Zone on the claystone-siltstone substrate of the Texas-Louisiana midshelf banks. One shelf-edge carbonate bank, Geyer Bank, also exhibits the zone but only on a bedrock prominence. Crusts of the hydrozoan coral, *Millepora alcicornis*, sponges, and other epifauna occupy the tops of siltstone, claystone, or sandstone outcrops in this zone. Scleractinian corals and coralline algae are rarely observed.

Antipatharian Zone
This transitional zone is not distinct but blends in with the lower Algal-Sponge Zone. It is characterized by an abundance of antipatharian whips growing with the algal-sponge assemblage. With increased water depth, the assemblages of the zone become less diverse, characterized by antipatharians, comatulid crinoids, few leafy or coralline algae, and limited fish (yellowtail reeffish, queen angelfish, blue angelfish, and spotfin hogfish). Again, the depth of this zone differs at the various banks but generally extends to 90 m.

Nepheloid Zone
High turbidity, sedimentation, and resuspension occur in this zone. Rocks or drowned reefs are covered with a thin veneer of sediment and epifauna are scarce. The most noticeable are comatulid crinoids, octocoral whips and fans, antipatharians, encrusting sponges, and solitary ahermatypic corals. The fish fauna is different and less diverse than those of the coral reefs or partly drowned reefs. These fish species include red snapper, Spanish flag, snowy grouper, bank butterflyfish, scorpionfishes, and roughtongue bass. This zone occurs on all banks, but its depth differs at each bank. Generally, the Nepheloid Zone begins at the limit of the Antipatharian Zone and extends to the surrounding soft bottom.

3.2.4.7.2.2 The Florida Middle Ground

The Florida Middle Ground on the west coast of Florida, is a 153,600 ha (379,392 ac) hard bottom area, 160 km west-northwest of Tampa, Florida. The area is characterized by steep profile limestone escarpments and knolls rising 10 to 13 m above the surrounding sand and sand-shell substrate, with overall depths varying from 26 to 48 m (Smith 1976).

The Florida Middle Grounds are depauperate in terms of coral species. The hydrozoan coral *Millepora alcicornis* is the dominant coral and major contributor to frame building on the Florida Middle Ground forming massive colonies along the rocky margins at about 27 m depth (Hopkins *et al*. 1977). The dominant scleractinians include *Madracis decactis*, *Porites divaricata*, *Dichocoenia stellaris, D. stokesii,* and *Scolymia lacera*. Although octocorals are a relatively minor component of other Gulf reefs, they are prominent on the Florida Middle Ground. Dominant forms of octocorals include *Muricea elongata*, *Muricea laxa*, *Eunicea calyculata*, and *Plexaura flexuosa*.

Species zonation pattern on the Florida Middle Ground as reported by Grimm and Hopkins (1977) are as follows:

1) *Muricea-Dichocoenia-Porites* zone at 26 to 28 m;
2) *Dichocoenia* and *Madracis* are dominant from 28 to 30 m ;
3) *Millepora* dominates from 30 to 31 m but becomes co-dominant with *Madracis* from 31 to 36 m.

3.2.4.7.2.3 The Dry Tortugas

The major reef types at the Dry Tortugas include bank reefs, patch reefs, and thickets of staghorn coral. Reefs are constructed principally by the massive scleractinian coral species. The once abundant elkhorn coral (*Acropora palmata*) assemblages (44 ha by Agassiz's estimate in 1882) have virtually disappeared from the area (Davis 1982; Jaap and Sargent 1993). In recent decades some of the staghorn coral populations (*Acropora cevicornis, A. prolifera*) have declined due to hypothermal stress (Roberts *et al*. 1982) and a virulent disease (Peters *et al*. 1983).

Spur and groove structures and large isolated formations with up to three meters of relief comprise the bank reef habitat in an arc along the northeast and southern margins of the Tortugas. Three species of coral (*Montastraea anmularis, M. cavernosa,* and *Siderastrea siderea*) were the principal builders of Bird Key Reef, which was estimated to be 5,883 years old by Shinn *et al*. (1977). Coral diversity, cover and habitat complexity increased with depth. Octocorals exhibited greatest species richness in depths less than 8 m, while coral cover was greatest between 9 and 13 m.

Patch reefs are isolated accumulations of massive corals that are often surrounded by seagrass and sediments. At the Tortugas, patch reefs lie inside the bank reef formations, to the south and east of Loggerhead Key, and to the west of Garden Key. The highest concentration of patch reefs is named Loggerhead Reef, and it lies southwest of Loggerhead Key (GMFMC 2000). Well developed patch reefs have massive colonies of *Montastraea anmularis*, that are several meters in diameter.

Submerged aquatic vegetation, rubble, and sediment surround the patch reefs. The massive corals often have small, eroded openings around the bases that provide refuge for a variety of invertebrates including lobsters and crabs, and dead areas are occupied by algae (*Halimeda* and *Dictyota*), sponges, octocorals, and other stony corals (*Porites porites*, *Mycetophyllia* ssp.) (GMFMC 2000).

Acropora cervicornis and *A. prolifera* are the two species of staghorn coral that create staghorn reefs. They have fast growth rates of approximately 11 cm per year (Shinn 1996; Jaap 1974).

Large thickets up to two meters high have virtually no other coral species associated with them. Prior to January 1977, staghorn reefs were the most commonly occurring reef in the Tortugas. But, this community is very susceptible to meteorological phenomena, and a cold front in January 1977 eliminated up to 95% of the extant staghorn reefs (Walker 1981; Davis 1982; Porter *et al*. 1982; Roberts *et al*. 1982).

Only a small remnant of elkhorn coral (*A. palmata*) still exists. After Hurricane Georges in October 1998, it has been reduced to an area approximately 800 square m, and thus is at risk of local extinction (GMFMC 2000).

Approximately 3,965 ha of octocoral-dominated hard bottom exists within the Dry Tortugas (Davis 1982), consisting of sea whips, sea plumes, and sea fans along its rather flat topography. Some areas have thick octocoral canopies. Monitoring at Pulaski shoal measured densities as high as 92.60 $\pm$ 31.74 colonies per square meter.

3.2.4.7.3 Prey species used by Coral FMU species

Since corals are sedentary organisms, the planktonic prey organisms they consume occur in the same habitats as the corals themselves (GMFMC and SAFMC 1982).

3.2.5 Fishery resources not under Council FMPs

In the Gulf of Mexico, highly migratory species (HMS, i.e. tuna, swordfish) and sharks are managed by NOAA Fisheries directly. Additionally, approximately nine species of nearshore fish and shellfish not included in Gulf Councils FMPs comprise the majority of the commercial and recreational harvest managed in state waters, resulting in significant social and economic benefits to the states and the nation. The Gulf States Marine Fisheries Commission, in coordination with the states, has completed FMPs for these species: menhaden, flounder, spotted seatrout, spanish mackerel, striped bass, blue crab, oyster, black drum, and striped mullet (GSMFC 2001). This section discusses status and habitat requirements of HMS and those nearshore species that are major prey for Council FMP species.

3.2.5.1 Highly migratory species

Highly migratory species (HMS) that are not under Federal FMPs include billfish and tunas. The principal concern comes over how removing these large apex predators, might affect the abundance of potential prey abundance species utilized by managed Gulf fishes. When apex predators such as billfishes, swordfish, tunas, and sharks are overfished, their removal may induce changes in the ecosystem, possibly affecting the abundances of some prey species also utilized by Council-managed fishes. These prey species are considered part of the habitat of the managed species, and such effects need to be considered. Apex predator removal may result in another predator (at the same trophic level) increasing in abundance, an increase in production at lower trophic levels (from the release of predation pressure), or long-term alterations of the ecosystem (Parsons 1992; Demers *et al*. 2001). Continued high rates of removal of tuna, swordfish, and shark adults and late juveniles might constitute a frequent and intense disturbance, with the capacity to induce large-scale changes in the biological characteristics of habitats, including some of those used by Council-managed species. Research into cascading ecological effects from apex predator removal should be encouraged.

Billfishes eat a wide variety of fishes including tunas, other scombrids, and dolphin (fish), and consume cephalopods (squids and octopods) as well as an assortment of other bony fishes and invertebrates. Some of these prey items are relatively large, fast-swimming fishes, which are unlikely to be preyed upon by any of the species managed by the Gulf Council. However, some other prey species are shared in common with Council-managed species, particularly squid, baitfishes (e.g. herrings, halfbeaks), crabs, and gastropods. In addition, large proportions of shrimp have been found in the stomachs of sailfish in the western Gulf (Beardsley *et al*. 1975; Nakamura 1985). These shrimp are both a prey resource for a number of Council-managed species, and a managed species themselves.

Swordfish feed inshore near the bottom during the day, and go out to sea to catch cephalopods at night. They eat a variety of demersal and pelagic fishes including tunas, dolphin (fish), and baitfishes. As with billfishes, while their fast-swimming pelagic fish prey items are unlikely to be taken by Council-managed species, many of the baitfishes, demersal fishes, and squid are in the prey field of some Council-managed fishes.

Tunas also consume various bony fishes, cephalopods, and invertebrates; particularly baitfishes, squid, and *Sargassum*-associated species. It is probable that many of these are also preyed upon by Council-managed species as well.

3.2.5.2 Shark

As with HMS, sharks also feed on many prey in common with Council-managed fishes, including menhaden, cephalopods, shrimp, blue crabs, mullet, lobster, sardines, marine catfish, and pinfish. They also eat fast-swimming bony fishes and small sharks, which are not taken by Council-managed species, and consume some of the managed species themselves.

3.2.5.3 Major prey species not under Council FMPs

3.2.5.3.1 Mullet

Mullet (*Mugil cephalus* and *M. curema* in the Gulf) are common prey species for many estuarine and marine fishes and cetaceans (Major 1978). They occur in coastal waters, estuaries, and rivers, ranging from Cape Cod to Brasil, including the Gulf of Mexico and the Caribbean (Amos and Amos 1985), and inhabit depths from 1-120 m. Eggs are found offshore in the planktonic environment, and pelagic larvae migrate inshore and enter estuaries (Ditty and Shaw 1996). Juveniles inhabit estuaries in marshes, impoundments, and high intertidal areas over mud and sand. Adults are found in estuaries and rivers over mud and sand bottoms, and also seagrasses and in mangroves (Harrison 1995). When it is time to spawn, adults migrate offshore and form large schools, but return to their home estuary when spawning is completed (Funicelli *et al.* 1989; Mahmoudi *et al*. 1989). Spawning occurs from October to mid-January. Larvae eat copepods and other zooplankton, but following metamorphosis to the juvenile phase, the diet shifts to detritus and algae which persists into the adult stage as well (Lee and Menu 1981). Adults and juveniles serve as prey for many fish and wildlife species including bluefish, snappers, barracudas, snook, lizardfish, bottlenose dolphin, alligators, and seabirds (Harrison 1995).

Mullet are harvested for both their flesh and roe (eggs from females) The flesh is of relatively low value, but the roe, which is mostly exported to Asian markets, commands a very good price (Ibanez-Aguirre *et al*. 1999). Roe-laden mullet are typically fished for during the fall and winter. The preferred method of capture utilizes gillnets, however in Florida the net ban that went into effect on July 1995, eliminated this method. Cast nets are the principal gear used at present in Florida.

3.2.5.3.2 Menhaden

Menhaden (*Brevoortia patronus*, *B. smithii*, and *B. gunteri* in the Gulf) are another abundant and widely utilized group of forage species. They are estuarine-dependent for much of their life cycle, and also occur in nearshore and offshore Gulf waters. They are pelagic schooling planktivores at all feeding life stages, occurring in depths from 1-140 m, but usually less than 18m (Christmas *et al*. 1982). The pelagic eggs are found in offshore and inshore waters. Most larval menhaden are found between 10-37 m (Shaw *et al*. 1985). Larvae are passively transported into Gulf estuaries, principally on flood tides (Govoni 1997). They inhabit low salinity areas, where they metamorphosize into juveniles (Castillo-Riviera and Kobelkowski 2000). It is believed that low salinity may trigger the metamorphic process (Christmas *et al*. 1982). Early juveniles inhabit unvegetated zones adjacent to marshes and tidal bayous (Rozas and Zimmerman 2000; Gelwick *et al*. 2001; Rozas and Minello 2001). Late juveniles move out into higher salinity open bay waters (Raynie and Shaw 1994). Adults occur in open bay waters and nearshore waters less than 18 m deep. Adults usually move offshore in the late fall/winter to spawn over the continental shelf. They may move as far offshore as 60 miles where water depths are 140 m, but they spawn most often closer to shore, in depths less than 18 m (Christmas *et al*. 1982). After spawning season, adults return to estuaries as water temperatures increase. Smaller larvae eat phytoplankton and microzooplankton, especially tintinnids and dinoflagellates. Larger larvae add copepods to their diet. Omnivorous juveniles and adults filter-feed via their gill rakers, and consume phytoplankton, zooplankton, detritus, and bacteria. Juvenile and adult menhaden are eaten by numerous species including bluefish, red drum, king mackerel, spotted seatrout, sharks, and bottlenose dolphin (Scharf and Schlicht 2000).

The following information on the menhaden fishery comes from the most recent fishery management plan by VanderKooy and Smith (2002). The menhaden reduction fishery is the largest in the Gulf of Mexico by volume, with peak catches occurring from May to August. The menhaden fishery is composed almost exclusively of *B. patronus*, with inconsequential catches of *B. smithii* and *B. gunteri*. It is a reduction fishery, with the fish used to produce fish meal, oil, and solubles. Effort and catch were at their peak in the early to mid 1980s, with annual landings over 800,000 metric tons (>1.76 billion pounds/year) for six years (1982-1987), and a record catch of 982,800 metric tons (2.17 billion pounds) in 1984. Landings have declined since that time, fluctuating, without trend, around 500,000 metric tons/year (1.1 billion pounds/year) since the mid-1990s. Recent fishing effort has been about two-thirds of effort during the 1980s peak. The fishery is highly efficient, using spotter planes, carrier vessels, and purse net boats to land fish and transport them back to processing plants.

Historically, menhaden companies, which own the processing plants, also own and operate the fishing vessels used in the fishery. Fleet size peaked in 1982 at 82 vessels, but has down-sized since then to 43 vessels. Similarly, the historical number of processing plants (13) has now decreased to four plants, due to mergers and an effort toward greater efficiency. Fishing is accomplished as follows. Initially, schools of menhaden are located by pilots in single-engine spotter planes, who direct the large carrier ships to them. Two smaller purse boats are launched from the carrier vessel, each purse vessel carrying one-half of the purse seine. The purse boats encircle the menhaden school with the purse seine, and purse the net bottom, capturing the fish. The carrier ship then pulls up to the purse boats and uses a pump to suck the menhaden out of the net and into the ship's hold. Menhaden schools vary in size from 3-100 metric tons, and are primarily age-1 and age-2 fish. Bycatch exclusion devices, which prevent large bycatch fishes from being drawn through the pump system, have been used since the 1950s. These exclusion devices usually consist of a hose cage and a large fish excluder used in combination.

Purse seines are approximately 1200 feet long and 60 or more feet deep. The purse boats are about 40 feet long and 11-12 feet wide, while the carrier vessels are from 140-200 feet long and can carry as much as 550 metric tons of menhaden. Typical crew size is 14, and they may make as many as 16 sets in a day. Vessels tend to fish near their home ports, and most of the catch comes from off the coast of Louisiana, with lesser amounts taken off Mississippi, Alabama, and Texas. There has been no large scale fishing off the Florida Panhandle since the early 1990s, and the use of purse seines in Florida territorial waters has been banned since 1994. Most catches come from sets made less than 10 miles from shore, and the highest catches come from Breton Sound, followed by Chandeleur and Mississippi Sounds. All catches are processed in Louisiana and Mississippi.

A small menhaden bait fishery has existed in Alabama for several years. The vast majority of the fish are harvested with gill nets. Preliminary Trip Ticket data from Alabama show that menhaden landings harvested with gill nets have varied from over 1.5 million pounds to slightly less than 1 million pounds in recent years (unpublished data, Alabama Department of Conservation and Natural Resources). Dockside prices have remained stable at approximately $0.11 per pound. The number of reported fishermen participating in this fishery has ranged from 32 to over 74 during this period (unpublished data, Alabama Department of Conservation and Naural Resources). Demand for this species does not appear to have declined. However, one of the primary dealers participating in the fishery stated that he has reduced his focus on menhaden in order to concentrate on more lucrative products.

There is also a small bait fishery for menhaden off Florida (using a tarp net) and Louisiana. These menhaden are used in traps by blue crab and crawfish fishers, and as chum by recreational fishers. Compared to the reduction fishery, the catch of the bait fishery is inconsequential.

Shrimp and industrial groundfish fisheries catch menhaden as bycatch, but this catch does not appear to be having a detrimental affect on the menhaden population.

In the menhaden reduction fishery, the most common bycatch is Atlantic croaker, striped mullet, hardhead catfish, threadfin shad, silver and sand seatrout, spot, gafftopsail catfish, and Atlantic bumper. Sharks are also caught, probably while feeding on menhaden schools, based on examination of their stomach contents. The current survival rate of large fish (> 1m total length) caught in a menhaden set is less than 28% (Rester and Condrey 1999). A study of shark bycatch found that sharks were caught in 30% of the menhaden sets observed (de Silva *et al*. 2001). Ten different shark species were caught as bycatch in the 492 sets (most commonly blacktip sharks, *Carcharhinus limbatus*), and annual shark bycatch was estimated to be 30,000 per year during 1995-1995. The study found that 74% of the sharks they observed died before release, 12% were disoriented, 8% were healthy at release, and the condition of the remaining 6% was unknown. They proposed that shark bycatch in the menhaden fishery might be affecting primary and secondary nursery grounds for sharks in the northern Gulf of Mexico (de Silva *et al*. 2001). A paper by de Silva and Condrey (1998) proposed that there are bycatch "hotspots" which can be identified.

Decreased landings since the 1980s are believed due to adverse environmental/meteorological conditions, which affect recruitment, survival, and growth. An alternative explanation could have to do with reduced fishing effort. As menhaden are a relatively short-lived fish with high natural mortality, and high fecundity they may exhibit rapid changes in annual stock size. At present, however, the stock seems to be reasonably stable (Vaughn *et al*. 2000). It is possible that menhaden may be sensitive to habitat changes and losses, particularly loss of wetland habitats, which are critical menhaden nursery areas.

3.2.5.3.3 Blue crab

Blue crab (*Callinectes sapidus*) occur throughout the Gulf of Mexico, where they are found in estuaries, rivers, nearshore, and offshore habitats during various life stages in salinities ranging from 0-60 ppt, and depths from 1-90 m (Guillory *et al.* 2001). Eggs are found near barrier islands or in high salinity waters near bay mouths or passes, attached to the abdomen of spawning females. Emerging larvae (zoeae) are pelagic and are carried offshore where they develop in waters over the continental shelf. Postlarvae (megalope) migrate into estuaries where they settle to the bottom in seagrass or shoreline habitats (Stuck and Perry 1982). Juveniles are found in seagrass and saltmarsh edge habitats, and also in rivers, mud, sand, benthic algae, and drift algae (Orth and Van Montfrans 1990). The quantity of habitat has been found to be positively related to blue crab production (Turner and Boesch 1988; Orth and Van Montfrans 1990). Adults occur in seagrass, benthic and drift algae, mud, sand, and saltmarsh (Heck and Thoman 1984). Adult females tend to reside in higher salinity areas than adult males do. After mating, males stay in the estuary, while females migrate to high salinity nearshore areas near barrier islands, bay, and passes to spawn (Guillory *et al*. 2001). Larvae (zoeae) are planktivorous and feed on algae, phytoplankton, and zooplankton. Postlarvae (megalope) eat fish larvae, small shellfish, and aquatic plants. Juvenile blue crabs consume assorted macroinvertebrates, including smaller blue crabs, fish, carrion, aquatic plants, and other vegetation. Adults feed on numerous prey including oysters, clams, fishes, carrion, aquatic plants, other blue crabs, macroalgae, detritus, shrimp, other crustaceans, gastropods, oligochaetes, and insect larvae (Perry and McIlwain 1986). Blue crabs are eaten by various organisms at different life stages. Eggs and larvae are consumed by shrimp, fish, jellyfish, and other planktivores. Postlarval blue crab are eaten by red drum, spotted seatrout, striped bass, catfish, spot, eels, birds, and also by other blue crabs. Juveniles are consumed by numerous fishes, birds, and other blue crabs. Adults are taken by red drum, black drum, croakers, spotted seatrout, cobia, toadfish, catfish, striped bass, gars, largemouth bass, eels, sharks, rays, sea turtles, herons, egrets, ducks, and racoons (Perry and McIlwain 1986).

3.2.5.3.4 Baitfish

Aside from menhaden other important prey species for large piscivorous marine predators in the Gulf include baitfish species such as Spanish sardines (*Sardinella aurita*), thread herring (*Opisthonema oglinum*), ballyhoo (*Hemiramphus brasiliensis*), balao (*Hemiramphus balao*), bigeye scad (*Selar crumenophthalmus*), and round scad (*Decapterus punctatus*). These species occur from the lower reaches of estuarine environments out to 90 miles offshore, although abundances tend to be higher in waters less than 18 m deep (FMRI 2000). Baitfish are mostly schooling pelagic fishes feeding on plankton either selectively or via filter feeding with specialized gill rakers. They will also occasionally consume small crabs, fish, and shrimp. Baitfish can be found in nearshore surface waters, and in estuaries among seagrasses, mangroves, and artificial structures like docks and pilings. They typically spawn in the pelagic zone of nearshore and offshore areas in depths from 9-50 m (FMRI 2000). The eggs are found offshore, and juveniles form large schools, which remain near the bottom during the day, and come to the surface at night. Two species follow as typical examples.

Spanish sardine occur from Cape Cod to Brazil from the continental shelf to the mouths of estuaries (Houde *et al*. 1983). They spawn over mid-shelf in the Gulf, and the eggs are pelagic and found offshore (Houde *et al*. 1979). Schooling juveniles feed on copepods and euphausids (Hildebrand *et al*. 1963), and stay near bottom during daylight hours, then vertically migrate to the surface at night to feed (Muller 2001). Adults also school and eat decapods, myctophid fish, and other small fish species (Muller 2001). Predators of juvenile and adult Spanish sardines include king mackerel, Spanish mackerel, little tunny, gag, bluefish, cravalle jack, yellow tuna, bluefin tuna, and dolphin (Johnson and Vaught 1986).

Ballyhoo and balao occur from New York to Brazil, and are found principally off south Florida in the Gulf of Mexico (McBride 2001). After spawning, eggs attach to floating blades of seagrass, and larvae also develop in association with floating grassblades (Muller 2001). Pelagic larval ballyhoo and balao both consume zooplankton. Juveniles and adults form surface-dwelling schools. Juvenile and adult ballyhoo eat zooplankton, such as copepods, siphonophores, and decapods, as well as seagrasses and small fishes. Juvenile and adult balao ingest zooplankton including copepods, siphonophores, polychaetes, annelids, decapods, and also small fishes, but no seagrasses (Berkeley *et al*. 1975; Berkeley and Houde 1978). In turn, ballyhoo and balao are eaten by large coastal pelagics, such as the mackerels (e.g. *Scomberomorus regalis*), sailfish, marlins, jacks, barracuda, blacktip shark (Randall 1967; Tabb and Manning 1961; DeSylva

1963), and also cetaceans (e.g. rough-toothed dolphin), and seabirds (e.g. *Anous stolidus*, *Sterna fuscata*; Hensley and Hensley 1995).

3.2.5.3.5 Oysters

American oysters (*Crassostrea virginica*) occur from Canada to the Gulf of Mexico, with centers of abundance in Long Island Sound, Chesapeake Bay, and the Gulf of Mexico (Stanley and Sellers 1986). Oysters in the Gulf belong to two races, those of the northern Gulf and those of the Apalachicola River (Lorio and Malone 1994). Their shells can form structures ranging in size from small clusters to extensive reefs in coastal estuaries, sounds, bays, and tidal creeks, and they are considered a keystone species (Wells 1961). Sedentary adults are broadcast spawners and, in the Gulf of Mexico, release eggs and sperm between March and November, when water temperatures are above 20 ° C. Mass spawning occurs at temperatures above 26° C (Schlesselman 1955). In addition, spawning generally only takes place when salinities remain above 10 ppt (Lorio and Malone 1994). Chemical cues in the water can also help to initiate spawning (e.g. from phytoplankton, other oyster eggs, dianthin from sperm). Female oysters will not spawn if environmental conditions are poor, presumably because not enough energy is available for gonadal development (Lorio and Malone 1994). A female may use up to 48% of her total energy budget for reproduction (Dame 1976).

The fertilized eggs sink, but hatch quickly, producing planktonic, free-swimming trochophore larvae. This stage is followed by the veliger larval stage, which spends three weeks in the plankton, then develops a “foot” and settles to the bottom seeking hard substrate (Andrews 1979; Bahr and Lanier 1981). Older larvae were stimulated to swim by relatively high salinities, while lower salinities inhibited swimming (Haskin 1964). The preferred substrate is adult oyster shell, and the larvae avoid areas with high siltation rates (Andrews 1979). If hard substrate is located, the newly settled larvae, called “spat”, cement themselves to the substrate and begin metamorphosizing to adult form. New generations of recruiting oysters build upon the cemented shell matrix of past generations, eventually forming oyster reefs. These reefs provide habitat to numerous fishes and invertebrate species (e.g. 40 species of macrofauna and up to 300 total species; Wells 1961; Bahr and Lanier 1981). They also absorb wave energy preventing shore erosion, and maintain water quality via their impressive filtering capacity (Lorio and Malone 1994).

In the Gulf, oysters normally inhabit areas with salinities ranging from 0-30 ppt, but can tolerate salinities from 2-40 ppt (Gunter and Geyer 1955). The best growth rates were found to occur in 12-30 ppt range, but highest abundances were found in salinities of 10-20 ppt (Butler 1954). Mortality was found to occur with extended exposure to freshwater (<2ppt; Gunter 1953). The most favorable water temperatures for growth range around 25-26° C. (Lorio and Malone 1994), but temperatures above 35° C. appear to be harmful (Tinsman and Maurer 1974). Gulf oysters occur in water depths from intertidal to 30 m.

Larval oysters feed on plankton, especially small, naked flagellates (i.e. chrysophytes; Guillard 1957). The filter-feeding adults consume algal phytoplankton, bacteria, detritus, and other organisms < 10 microns in size (Lorio and Malone 1994). Oyster eggs, embryos, and early larvae are preyed upon by protozoans, ctenophores, jellyfish, hydroids, worms, bivalves, barnacles, crabs, and juvenile/adult fishes (Lorio and Malone 1994). Oyster spat and adults are eaten by numerous species including the stone crab, blue crab, black drum, southern oyster drill, crown conch, lightning whelk, starfish, mud crab, boring sponge, sea anemone, flatworm, southern eagle ray, and cownose ray (Marshall 1954; Schlesselman 1955; Menzel and Hopkins 1956; Guillard 1957; Menzel and Nicky 1958; Menzel *et al*. 1966; Mackenzie 1970; Steinberg and Kennedy 1979; and Cake 1983).

3.2.5.3.6 Removal of prey by fishing activities

While the removal of large, slow-growing predatory fishes from ecosystems due to fishing activities has been recognized as a problem which may alter the structure of a fish community (Brown *et al.* 1998), there has also been some public concern over the removal of prey fishes. Removal of prey species may be intentional, as with the menhaden fishery, or unintentional, as with bycatch of non-target species. Bycatch is a major issue in some fisheries such as the shrimp fishery. Gulf shrimp trawls may capture up to 115 non-target fish species totaling 9 billion fish per year as bycatch, including as many as 41 million red snapper (Bryan et al. 1982; Nichols and Pellegrin 1992; NMFS 1996a). Many targeted prey species like menhaden are fast-growing, short-lived organisms and tend to recover from heavy harvest more quickly than slower growing species, therefore prey species harvest is considered less problematic (Vaughn *et al.* 2000). At present, the intentional removal of prey species in the Gulf is not known to be adversely affecting any of the managed species. However, food chain alterations are poorly understood, and the complexity of marine ecosystems makes proving "cause and effect" relationships very difficult (Alaska Sea Grant 1993).

3.2.6 Marine mammals and protected (threatened and endangered) species

There are 28 cetacean, one sirenian, and one non-native pinneped (California sea lion) species that have confirmed occurrences in the Gulf of Mexico (Davis *et al*. 2000). Of these, six marine mammal species are listed as endangered species. Additionally, all five of the sea turtles found in the Gulf of Mexico (Kemp's ridley, loggerhead, green, leatherback, and hawksbill) are protected under the Endangered Species Act (ESA). Gulf sturgeon is listed as threatened, and smalltooth sawfish has recently been listed as endangered. Thirteen species of fish are currently on the candidate list. The most recently completed NOAA Fisheries Biological Opinions for these species include the Gulf of Mexico Outer Continental Shelf Multi-Lease Sale (November 29, 2002) and Shrimp Trawling in the Southeastern United States, under the Sea Turtle Conservation Regulations and as managed by the Fishery Management Plans for Shrimp in the South Atlantic and the Gulf of Mexico (December 2, 2002). These reports contain the most updated information on Gulf of Mexico protected species.

On February 28, 2003 the final critical habitat rule, as defined under the ESA, was published for the Gulf sturgeon. No critical habitat is currently designated for any marine protected species in the Gulf of Mexico.

3.2.6.1 Marine mammals

3.2.6.1.1 Sperm whale (*Physeter macrocephalus*)

Sperm whales were listed as endangered under the ESA in 1973 (NMFS 2001f). They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the Marine Mammal Protection Act of 1972. Critical habitat has not been designated for sperm whales. There is no critical habitat designated for sperm whales. The primary factor for the species' decline, that precipitated ESA listing, was commercial whaling (Blaylock *et al.* 1995). Sperm whales were hunted in America from the 17th century through the early 1900s, but the exact number of whales harvested in the commercial fishery is not known (Townsend 1935). A commercial fishery for sperm whales operated in the Gulf of Mexico during the late 1700s to early 1900s. Since the ban on nearly all hunting of sperm whales, there has been little evidence that human-induced mortality or injury is significantly affecting the recovery of sperm whale stocks. . The Southeast U.S. Marine Mammal Stranding Newtwork received reports of 17 sperm whales that stranded along the Gulf of Mexico coastline from 1987 to 2003 in areas ranging from Pinellas County, Florida to Matagorda County Texas. The International Whaling Commission manages sperm whales as four stocks, but Dufault *et al.* (1999) reviewed current knowledge of sperm whales and found no clear picture of worldwide stock structure. NOAA Fisheries believes there are insufficient data to determine population trends for this species.

The presence of sperm whales in the Gulf is year-round. Based on a year-round occurrence of strandings, genetics, opportunistic sightings and whaling catches, sperm whales in the Gulf of Mexico constitute a distinct stock, and indeed, they are treated as such in NOAA Fisheries' Marine Mammal Stock Assessment Report (Schmidley 1981; Waring *et al.* 2000; Engelhaupt 2003). Sperm whale pods have been observed throughout the Gulf of Mexico from the upper continental slope near the 100 m isobath to the seaward extent of the EEZ and beyond from sightings data collected during NOAA cruises between 1999-2000 (Roden and Mullen 2000; Baumgartner *et al*. 2001; Burks *et al*. 2001). A group found offshore of the Mississippi River Delta is likely a resident population. The area exhibits high primary and secondary productivity in deep water which may explain the presence of the resident population (Townsend 1935; Berzin 1971; Davis and Fargion 1996; Davis *et al*. 2000; Weller *et al*. 2000). Researchers with Texas A&M believe that the area should be considered critical habitat for sperm whales (Davis 2000), because these waters are the only known breeding and calving area in the Gulf of Mexico for the presumably resident population (Davis *et al*. 2002). The Gulf stock is primarily composed of females and calves, but some large mature bulls have recently been sighted. Although sperm whales have been sighted throughout the Gulf of Mexico, those south of the Mississippi River Delta seem to stay near variable areas of upwelling or cold-core rings, presumably due to the greater productivity in these areas (Wursig *et al*. 2000; Davis *et al*. 2002).

The worldwide population of sperm whales is thought to be about 32% of its pre-whaling size (Whitehead 2002). Sperm whales are the most abundant large cetacean in the Gulf of Mexico, and represent the most important Gulf cetacean in terms of collective biomass. The Gulf of Mexico sperm whale stock is estimated at 1,213 sperm whales, calculated from an average of estimates from 1996-2001 surveys (Mullin and Fulling, in prep.). The minimum population estimate (N_{min}) is 911 sperm whales. The estimate of N_{min} is calculated as the lower limit of the two-tailed 60% confidence interval of the lognormal distributed abundance estimate (or the equivalent of the 20th percentile of the lognormal distributed abundance estimate as specified by NOAA Fisheries. N_{min} is a required component of the Potential Biological Removal level (PBR) calculation as required under the MMPA. The estimated PBR for the Gulf sperm whale stock is 1.8 sperm whales. PBR is an estimate of the number of animals, which can be removed (in addition to natural mortality) annually from a marine mammal population or stock while maintaining that stock at OSP (optimum sustainable population level) or without causing the population or stock to slow its recovery to OSP by more than 10%. Stock size is considered to be low relative to OSP; there is no trend in population size discernable from estimates of abundance over time (Waring *et al.* 2000 and references within).

Cephalopods (i.e. squid, octopi, cuttlefishes, and nautili) are the main dietary components of sperm whales in the Gulf of Mexico (Davis et al. 2002). Other populations are known to also take significant quantities of large demersal and mesopelagic sharks, skates, and bony fishes (Clark 1962, 1979). Sperm whales may hunt by ambushing prey, attracting prey with bioluminescent mouths, or stunning prey with ultrasonic sounds (Norris and Mohl 1983; Berzin 1971; Wursig *et al*. 2000). Sperm whales occasionally drown after becoming entangled in deep-sea cables that wrap around their lower jaw, and non-food objects have been found in their stomachs, suggesting these animals may sometimes cruise the ocean floor with their mouths open (Wursig *et al*. 2000; Rice 1989).

3.2.6.1.2 Other whales

During spring through late fall, right whales are found off Canada and the northeast United States in feeding areas (MMS 2000). Winter distribution for the majority of the population is unknown, but coastal waters between Georgia and Florida are the only known calving areas for these whales. Existing records of this species in the Gulf of Mexico represent strays from the wintering grounds outside of the normal distribution range.

There are only two reliable records (strandings on the Texas coast) of blue whales in the Gulf of Mexico, and they are not thought to be regular inhabitants of the Gulf (MMS 2000).

The sei whale probably has only an accidental occurrence in the Gulf (though it is interesting to note that three of the four reliable records were from strandings on the eastern Louisiana coast) (MMS 2000).

Humpback whales spend winter in warm waters to calve, and then move to colder waters to feed during the summer (MMS 2000). The few reports of humpback whales in the Gulf are considered to be whales that may have lost their way on return northerly migrations (from the Caribbean) in the western North Atlantic.

The fin whale is found in all major oceans in the world. Like other large baleen whales, it migrates seasonally from temperate waters where it mates and calves in the winter to polar feeding grounds in the summer (USM no date). The wintering grounds of the north Atlantic stock are the Caribbean Sea and Gulf of Mexico. Stocks of the North Atlantic were heavily fished and soon depleted. There are now only a few thousand fin whales in the North Atlantic. Pre-exploitation populations have been estimated at over 464,000, with about 18,000 in the North Atlantic, 45,000 in the North Pacific, and 400,000 in the Southern Ocean (NMFS 1991). Current stocks were estimated to include about 119,000 individuals, with about 17,221 in the North Atlantic, 16,625 in the North Pacific, and 85,200 in the Southern Ocean. Sightings and strandings indicate that fin whales continue to use the Gulf of Mexico as part of their wintering habitat, although in limited number (Davis *et al*. 1995). If the protected populations in the Atlantic increase, the Gulf will likely be used more frequently as a wintering ground for these mammals.

3.2.6.1.3 Dolphins

Nine species of dolphins occur in the Gulf of Mexico (Waring *et al*. 2000). All are members of the family Delphinidae, and none are considered threatened or endangered. Most inhabit deeper waters in the Gulf, with the exception of the bottlenose and Atlantic spotted dolphins. The bottlenose (*Tursiops truncatus*) is the most common dolphin in nearshore waters and outer edge of the continental shelf in the Gulf. The Atlantic spotted dolphin (*Stenella frontalis*) is the only other species that commonly occurs over the continental shelf, typically inhabiting shallow waters within the 250-m isobath.

The Risso's (*Grampus griseus*), Clymene (*Stenella clymene*), spinner (*Stenella longirostris*), striped (*Stenella coeruleoalba*), and rough-toothed (*Steno bredanensis*) dolphins are deepwater species endemic to tropical and subtropical waters. Other Gulf species include the pantropical spotted dolphin (*Stenellas attenuata*) and Fraser's dolphin (*Lagenodelphis hosei*).

3.2.6.1.4 Manatees (*Trichechus manatus latirostris*)

The West Indian manatee is found throughout the coastal waters of Florida (Waring *et al*. 2000), and it is listed as an endangered species throughout its range. These large mammals are normally found in nearshore shallow coastal and estuarine waters where they feed on seagrasses and aquatic vegetation. Manatees also are found far up freshwater rivers and streams. On Florida's Gulf coast, they commonly range from the Everglades northward to the Suwanee River, are somewhat less abundant northward in the Big Bend area, and occur even less frequently westward. However, manatees have been occasionally found as far west as Louisiana and Texas (Powell and Rathbun 1984 ; Rathbun *et al*. 1990; Schiro *et al*. 1998).

Manatee winter range is more restricted than summer range due to migration toward warmer areas. Manatees have a very low metabolic rate and high thermal conductance that can lead to energetic stresses during cold periods (O'Shea *et al*. 1995). Thus, in winter, they are generally found at the southern tip of Florida or congregated at warm-water sources, most commonly power plants. On the Gulf Coast, there are nine aggregation sites, the major ones being the natural springs on the Crystal and Homasasa Rivers; Tampa Electric Company's Big Bend Power Plant on the east side of Tampa Bay (Apollo Beach); Florida Power Corporation's Bartow

Power Plant at Weedon Island, west side of Tampa Bay; Florida Power & Light Company's Fort Myers Power Plant in Lee County; and Port of the Islands Marina in Collier County.

In January 2001, a record number of manatees were counted in three synoptic aerial surveys. Favorable weather conditions were considered to have contributed in part to the record count, which produced a total number of 3,276 manatees, including 1,765 counted by observers on Florida's Gulf Coast (Florida Marine Research Institute 2001). For the five years from 1995 to 2000, the annual count averaged 2,293 manatees.

As herbivores, manatees feed opportunistically on a wide variety of submerged, floating, and emergent vegetation. They often use secluded canals, creeks, embayments, and lagoons near mouths of coastal rivers and sloughs for feeding, resting, mating, and calving (USDOI FWS 1995).

The primary threats to manatees are loss of manatee habitats and human-related mortality and injury (both generally due to collision with vessels), and disturbance. In 2000, there were 273 total manatee deaths statewide, with 78 of these due to collision with watercraft, eight due to floodgates or canal locks, eight due to other human causes and 62 undetermined. All other deaths were perinatal (58), due to natural causes and cold stress (14), or unrecovered (8). In Gulf Coast counties alone, there were 35 deaths due to collision with watercraft, 35 that were undetermined, and four due to other human causes (FMRI 2001).

3.2.6.2 Marine turtles

3.2.6.2.1 Green (*Chelonia mydas*)

The green sea turtle was listed under the ESA on July 28, 1978 as threatened, except for Florida and the Pacific coast of Mexico breeding populations which were listed as endangered. They are distributed circumglobally, mainly in waters between the northern and southern 20^{o} C isotherms (Hirth 1971). Green turtles were traditionally highly prized for their flesh, fat, eggs, and shell. Fisheries in the United States and the Caribbean are largely to blame for the decline of the species.

Green sea turtle mating occurs in waters off the nesting beaches. Mature females mate every 2-4 years, but males mate every year (Balazs 1983). Age at sexual maturity is estimated to be between 20 and 50 years (Balazs 1982; Frazer and Ehrhart 1985). On nesting beaches, females lay 1-7 clutches (3-4 is likely) during the breeding season at 12-14 day intervals. Clutch size varies, but averages around 110-115 eggs. In the continental United States, green turtle nesting occurs on the Atlantic coast of Florida. Occasional nesting has been documented along the Gulf coast of Florida, on southwest Florida beaches, as well as the beaches on the Florida Panhandle (Meylan *et al.* 1995). The vast majority of green turtle nesting within the southeast region occurs in Florida where green turtle nesting has been extensively and consistently surveyed during the period 1989-1999 (NMFS 2001f). In Florida during the 11-year period, green turtle abundance from nest counts ranges 109-1389 nesting females per year. High biennial variation and a predominant two-year re-migration interval (Witherington and Ehrhart 1989; Johnson and

Ehrhart 1994) warrant combining even and odd years into two-year cohorts. This gives an estimate of total nesting females of 705-1509 during the period 1990-1999. In Florida during the period 1989-1999, numbers of green turtle nests by year show no trend ($n = 11$, $r^2 = 0.055$, $p = 0.49$). However, odd-even year cohorts of nests (as described and as justified above) did show a significant increase ($n = 5$, $r^2 = 0.72$, $p = 0.033$) during the period 1990-1999 (Florida Marine Research Institute, Index Nesting Beach Survey Database). Total nest counts and trends at index beach sites during the past decade suggest that green turtles that nest within the southeast region are recovering and have only recently reached a level of approximately 1000 nesting females.

After hatching, green sea turtles go through a post-hatchling pelagic stage where they are associated with drift lines of algae and other debris. These post-hatchling individuals are assumed to be omnivorous, but little data are available.

While nesting activity is obviously important in identifying population trends and distribution, the majority of a green turtle's life is spent on the foraging grounds. Green turtles are herbivores and appear to prefer marine grasses and algae in shallow bays, lagoons, and reefs (Rebel 1974). Some of the principal feeding pastures in the Gulf of Mexico include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas, the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs, Florida Bay and the Florida Keys, and the northwestern coast of the Yucatan Peninsula (Caldwell and Carr 1957; Hildebrand 1982; Carr 1984; Doughty 1984; Shaver 1994; Schroeder and Foley 1995). The preferred food sources in these areas are *Syringodium, Thalassia, Zostera, Sagittaria,* and *Vallisneria* (Babcock 1937; Underwood 1951; Carr 1952, 1954). There are no reliable estimates of the overall number of green turtles inhabiting foraging areas within the southeast United States, and it is likely that green turtles foraging in the region come from multiple genetic stocks.

Green turtles were once abundant enough in the shallow bays and lagoons of the Gulf of Mexico to support a commercial fishery, which landed over one million pounds of green turtles in 1890 (Doughty 1984). Doughty reported the decline in the turtle fishery throughout the Gulf of Mexico by 1902. Currently, green turtles are uncommon in offshore waters of the northern Gulf, but abundant in some inshore embayments. Shaver (1994) live-captured a number of green turtles in channels entering into Laguna Madre in south Texas. She noted the abundance of green turtle strandings in Laguna Madre inshore waters and opined that the turtles may establish residency in the inshore foraging habitats as juveniles.

The known and potential sources of impacts to green turtles include both domestic and international trawl, gillnet, hook and line, pelagic longline, pound net, long-haul seine, and channel net fisheries, as well as non-fishery impacts from power plants, marine pollution (ingestion of tar balls and plastic, entanglement, degradation of foraging grounds), oil and gas extraction activities, development, transportation, underwater explosions, dredging, offshore artificial lighting, marina and dock construction and operation, boat collisions, and poaching (TEWG 1998, MMS 2002a). On their nesting beaches in the U.S., green turtles are threatened with beach erosion, armoring, and renourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; exotic dune and beach vegetation; poaching ; and predation by species such as fire ants, racoons (*Procyon lotor*), armadillos (*Dasypus* *novemcinctus*), and opossums (*Didelphus virginianus*). A more thorough description of anthropogenic mortality sources is provided in the TEWG reports (1998, 2000).

Fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body , has been found to infect green turtles, most commonly juveniles. The occurrence of fibro papilloma tumors, may result in impaired foraging, breathing, or swimming ability, leading potentially to death. This had become a serious concern for this species.

3.2.6.2.2 Hawksbill (*Eretmochelys imbricata*)

Hawksbill turtles have been listed as an endangered species since June 2, 1970. In the Western Atlantic, the largest hawksbill nesting population occurs in the Yucatán Peninsula of Mexico, where several thousand nests are recorded annually in the states of Campeche, Yucatán, and Quintana Roo (NMFS 2001f). In the northern Gulf of Mexico, a number of small hawksbills are encountered in Florida and Texas. Most of the Texas records are probably in the 1–2 year class range. Long-term trends in hawksbill nesting in Florida are unknown, although there are a few historical reports of nesting in south Florida and the Keys (True 1884, Audubon 1926, DeSola 1935). No nesting trends were evident in Florida from 1979 to 2000; between 0 and 4 nests are recorded annually. The hawksbill has been recorded in all of the Gulf states. Nesting on Gulf beaches is extremely rare and one nest was documented at Padre Island in 1998 (Mays and Shaver 1998).

The life history of hawksbills consists of a pelagic stage beginning when they leave the nesting beach as hatchlings until they reach about 22-25 cm in straight carapace length, followed by residency in nursery habitats (foraging grounds) where immature individuals grow (Meylan 1988). Adult foraging habitats include coral reefs, hard bottoms, and mangrove-fringed bays. They feed primarily on a wide variety of sponges but also consume bryozoans, coelenterates, and mollusks. The lack of sponge-covered reefs, and the cold winters of the northern Gulf of Mexico probably prevent hawksbills from establishing a strong presence in that area.

Pelagic-size individuals and small juveniles are not uncommon and are believed to be animals dispersing from nesting beaches in the Yucatán Peninsula of Mexico and farther south in the Caribbean (Amos 1989). The majority of hawksbill sightings are reported from the sea turtle stranding network. Nesting areas in the western North Atlantic include Puerto Rico and the Virgin Islands. Many of the individuals captured or stranded are unhealthy or injured (Hildebrand 1983). Pinellas County, Florida, including Tampa Bay, has the largest share of west coast hawksbill strandings. Strandings from 1972–1989 were concentrated at Port Aransas, Mustang Island, and near the headquarters of the Padre Island National Seashore, Texas (Amos 1989). Live hawksbills are sometimes seen along the jetties at Aransas Pass Inlet. Other live sightings include a 24.7-cm juvenile captured in a net at Mansfield Channel in May 1991 (Shaver 1994b), and periodic sightings of immature animals and adults in the Flower Gardens National Marine Sanctuary (Hickerson 2000). It is likely that immature hawksbills utilize the various hard-bottom habitats off the west coast as developmental habitat (NMFS 2001f).

Hawksbills may undertake developmental or reproductive migrations that involve hundreds or thousands of kilometers of travel (Meylan 1999). Reproductive females make periodic (non-annual) migrations to their natal beaches, and males are presumed to make migrations to nesting beaches or courtship stations along the migratory corridor. Females nest about 3-5 times per season, with clutch sizes up to 250 eggs (Hirth 1980).

Hawksbills are threatened by all the factors that threaten other sea turtles, including exploitation for meat, eggs, and the curio trade, loss or degradation of nesting and foraging habitats, increased human presence, nest predation, oil pollution, incidental capture in fishing gears, ingestion of or entanglement in marine debris, and boat collisions (Lutcavage *et al*. 1997; Meylan and Ehrenfeld 2000). Historically, the decline of the species has been attributed to exploitation for its beautifully patterned tortoiseshell scales (Parsons 1972). International trade in tortoiseshell is now prohibited among all signatories of the Convention on International Trade in Endangered Species, but some illegal trade in both signatory and non-signatory countries still continues.

3.2.6.2.3 Kemp’s ridley (*Lepidochelys kempii*).

Kemp’s ridley turtles have been listed as an endangered species since December 2, 1970. Of the seven extant species of sea turtles of the world, the Kemp's ridley has declined to the lowest population level (NMFS 2001f). The Recovery Plan for the Kemp's Ridley Sea Turtle (USFWS and NMFS 1992) contains a description of the natural history, taxonomy, and distribution of the Kemp's ridley turtle. Kemp’s ridleys nest in daytime aggregations known as arribadas, primarily at Rancho Nuevo, a stretch of beach in Mexico. Most of the population of adult females nest in this single locality (Pritchard 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1982). By the early 1970s, the world population estimate of mature female Kemp’s ridleys had been reduced to 2,500 to 5,000 individuals. The population declined further during the mid-1980s. Recent observations of increased nesting suggest that the decline in the ridley population has stopped, and there is cautious optimism that the population is now increasing (TEWG 1998).

The age at maturity for this species is estimated to range from 7 to 15 years. Nesting occurs from April into July. Some females nest annually, but the weighted mean migration rate is about 2 years. Females lay approximately 2.5 nests per season at around 100 eggs per nest. Little is known of the movements of the post-hatchling, planktonic stage within the Gulf. Studies have shown the post-hatchling pelagic stage varies from 1 to 4 or more years, and the benthic immature stage lasts 7 to 9 years (Schmid and Witzell 1997).

The nearshore waters of the Gulf of Mexico are believed to provide important developmental habitat for juvenile Kemp's ridley and loggerhead sea turtles. Ogren (1988) suggests that the Gulf coast, from Port Aransas, Texas, through Cedar Key, Florida, represents the primary habitat for subadult ridleys in the northern Gulf of Mexico. This species generally remains within the 50-m isobath of coastal areas throughout the Gulf of Mexico (Renaud 2001). Stomach contents of Kemp's ridleys along the lower Texas coast had a predominance of near shore crabs and mollusks, as well as fish, shrimp and other foods considered to be shrimp fishery discards

(Shaver 1991). Analyses of stomach contents from sea turtles stranded on upper Texas beaches apparently suggest similar near shore foraging behavior (Plotkin, personal communication).

Research being conducted by Texas A&M University suggests that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, personal communication).

In recent years, unprecedented numbers of Kemp's ridley carcasses have been reported from Texas and Louisiana beaches during periods of high levels of shrimping effort (NMFS 2000). NMFS established a team of population biologists, sea turtle scientists, and managers, known as the Turtle Expert Working Group (TEWG), to conduct a status assessment of sea turtle populations. Analyses conducted by the group have indicated that the Kemp’s ridley population is in the early stages of recovery (TEWG 1998).

Nesting data indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and a low of 702 nests in 1985 (NMFS 2000). This trajectory of adult abundance tracks trends in nest abundance from an estimate of 9,600 in 1966 to 1,050 in 1985. The TEWG estimated that in 1995 there were 3,000 adult ridleys. The TEWG indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion (TEWG 1998). Over the period 1987 to 1995, the rate of increase in the annual number of nests accelerated in a trend that would continue with enhanced hatchling production and the use of TEDs. During 2002 there were 6,426 Kemp’s ridley nests on Mexican beaches and 40 nests on U.S. beaches (Columbus Brown, U.S. Fish and Wildlife Service, personal communication). The data reviewed suggested that adult Kemp's ridley turtles were restricted somewhat to the Gulf of Mexico in shallow nearshore waters, and benthic immature turtles of 20–60 cm straight line carapace length are found in nearshore coastal waters including estuaries of the Gulf of Mexico and the Atlantic. The population model in the TEWG projected that Kemp’s ridleys could reach the intermediate recovery goal identified in the Recovery Plan, of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates used in their model are correct.

The severe decline in the Kemp’s ridley population appears to have been heavily influenced by a combination of exploitation of eggs and impacts from fishery interactions. From the 1940s through the early 1960s, nests from Rancho Nuevo, Mexico were heavily exploited, but beach protection in 1966 helped to curtail this activity. Currently, anthropogenic impacts to the Kemp’s ridley population include interactions with fishery gear, marine pollution, destruction of foraging habitat, and threats at nesting beaches.

3.2.6.2.4 Leatherback turtle (*Dermochelys coriacea*)

Leatherback turtles have been listed as an endangered species since June 2, 1970. The Recovery Plan for Leatherback Turtles (*Dermochelys coriacea*) contains a description of the natural history and taxonomy of this species (USFWS and NMFS 1992). Leatherbacks are widely distributed throughout the oceans of the world, and are found throughout waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972). Leatherbacks are predominantly pelagic, feeding primarily on jellyfish such as *Stomolophus, Chryaora,* and *Aurelia* (Rebel

1974). Leatherbacks are deep divers, with recorded depths of greater than 1000 m. They may come into shallow waters if there is an abundance of jellyfish near shore, and they are believed to be night feeders (Eckert *et al*. 1989).

The status of the leatherback population is difficult to assess since major nesting beaches occur over broad areas within tropical waters outside the United States (NMFS 2000). The primary leatherback nesting beaches occur in French Guiana and Suriname in the western Atlantic and in Mexico in the eastern Pacific. Although increased observer effort on nesting beaches has resulted in increased reports of leatherback nesting, declines in nest abundance have been reported from the beaches of greatest nesting densities. Some nesting occurs on Florida's east coast. The most recent data, from 2002, reported 596 nests on Florida beaches.

Leatherbacks are long-lived (>30 years), but females mature relatively earlier than other sea turtle species at around 13 to 14 years old (Zug and Parham 1996; NMFS 2001g). Nesting activity in the U.S. occurs from March through July. Females can lay up to 7 nests per season, with nesting occurring every 2 to 3 years. Clutch size is about 100 eggs per nest, but a portion of these eggs are infertile.

The leatherback is the most abundant sea turtle in waters over the northern Gulf of Mexico continental slope (Mullin and Hoggard 2000). Leatherbacks appear to spatially use both continental shelf and slope habitats in the Gulf (Fritts et al. 1983, Collard 1990), but primarily utilize pelagic waters > 200 m (Davis and Fargion 1996) throughout the northern GOM. Recent surveys suggest that the region from the Mississippi Canyon to DeSoto Canyon, especially near the shelf edge, appears to be an important habitat for leatherbacks (Mullin and Hoggard 2000). Leatherbacks are year-round inhabitants in the GOM with frequent sightings during both summer and winter (Mullin and Hoggard 2000). Temporal variability and abundance suggest that specific areas may be important to this species, either seasonally or for short periods of time.

Threats to leatherbacks include domestic and international trawl, gillnet, hook and line, pelagic longline, fish trap, lobster pot, whelk pot, long-haul seine, and channel net fisheries, as well as non-fishery impacts like marine pollution, marine debris (e.g. ingestion of plastic; entanglement), harvest of eggs and adults in foreign countries, oil and gas extraction activities, development, transportation, underwater explosions, dredging, offshore artificial lighting, marina and dock construction and operation, boat collisions, and poaching (TEWG 1998; MMS 2002a). On their nesting beaches in the U.S., leatherbacks turtles are threatened with beach erosion, armoring, and renourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; exotic dune and beach vegetation; poaching ; and predation by species such as fire ants, racoons (*Procyon lotor*), armadillos (*Dasypus novemcinctus*), and opossums (*Didelphus virginianus*). A more thorough description of anthropogenic mortality sources is provided in the TEWG reports (1998, 2000).

Of the Atlantic sea turtles species, leatherbacks seem to be more susceptible to entanglement in fishing gears such as lobster gear lines and longline gear, as opposed to swallowing hooks. This susceptibility may be the result of attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, and perhaps to light sticks used to attract target species in the longline fishery. Leatherbacks are exposed to a series of longline fisheries while circumnavigating the ocean basin. According to observer records, an estimated 6,363 leatherbacks were caught by just the U.S. tuna and swordfish longline fisheries between 1992-1999, of which 88 were released dead (NMFS 2001g).

Leatherbacks may be more susceptible to marine debris ingestion than other species due to their pelagic existence and the tendency of floating debris to concentrate in convergence zones which adults and juveniles use for feeding areas and migratory routes (Lutcavage et al. 1997; Shoop and Kenney 1992). Investigations of stomach contents of leatherbacks revealed that a substantial percentage (44%) contained plastic (Mrosovsky 1981). The presence of plastic debris in the digestive tract suggests that leatherbacks may not be able to distinguish between prey items and plastic debris (Mrosovsky 1981). Balazs (1985) speculated that the object may resemble a food item by its shape, size, color, or even movement as it drifts about, and induces a feeding response.

3.2.6.2.5 Loggerhead turtle (*Caretta caretta*)

Loggerhead sea turtles have been listed as a threatened species since 1978. They occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans and are the most abundant species of sea turtle occurring in U.S. waters (NMFS 2001f). The loggerhead is a highly migratory species and is found in waters around the globe. In the Gulf of Mexico, sightings of loggerheads in waters over the continental slope suggest that they may be in transit through these waters to distant foraging sites or while seeking warmer waters during the winter. Although loggerhead are widely distributed during both summer and winter, their abundance in surface waters over the slope was greater during the winter than in summer (Mullin and Hoggard 2000), and many sightings occurred near the 100-m isobath (Davis et al. 2000). Surface sightings have also been made over the outer slope, approaching the 2,000 m isobath. The nearshore waters of the Gulf of Mexico are believed to provide important developmental habitat for juvenile loggerheads. Studies conducted on loggerheads stranded on the lower Texas coast (south of Matagorda Island) have indicated that stranded individuals were feeding in nearshore waters shortly before their death (Plotkin *et al.* 1993).

In the western Atlantic, most loggerhead sea turtles nest from North Carolina to Florida and along the gulf coast of Florida. The most recent data, for year 2002, is 62,905 nests along 1,284 km of beach in Florida. The TEWG report identified four nesting subpopulations of loggerheads in the western North Atlantic based on mitochondrial DNA evidence (TEWG 1998). A fifth subpopulation was subsequently identified (NMFS 2001g). These include: (1) the northern subpopulation producing approximately 7,500 nests in 1998 from North Carolina to northeast Florida; (2) the south Florida subpopulation occurring from just north of Cape Canaveral on the east coast of Florida and extending up to Naples on the west coast and producing approximately 83,400 nests in 1998; (3) the Florida Panhandle subpopulation, producing approximately 1,200 nests in 1998; (4) the Yucatan subpopulation occurring on the northern and eastern Yucatan Peninsula in Mexico, producing approximately 1,000 nests in 1998; and the Dry Tortugas nesting population occurring in the islands of the Dry Tortugas, near Key West, Florida producing 200 nests per year (NMFS 2001g).

Past literature gave an estimated age at maturity of 21 to 35 years (Frazer and Ehrhart 1985; Frazer *et al*. 1994) and reported the benthic immature stage as lasting 10 to 25 years. However, NMFS Southeast Regional Fisheries Science Center reviewed the literature and constructed growth curves from new data, estimating ages of maturity among four models ranging from 20 to 38 years and benthic immature stage lengths from 14 to 32 years (NMFS 2001g). Mating takes place in late March to early June, and eggs are laid throughout the summer. Adult males are seasonally abundant near nesting beaches during the nesting season (TEWG 1998). Female loggerheads lay an average of 4.1 nests per nesting season (Murphy and Hopkins 1984) and have an average remigration interval of 2.5 years. Mean clutch size varies from about 100 to 126 eggs per nest along the southeastern U.S. coast. Loggerheads originating from Western Atlantic nesting are believed to lead a pelagic existence in the North Atlantic Gyre for 7 to 12 years, and are referred to as pelagic immatures. Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm Straight Carapace Length (SCL) they recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico and become benthic immatures.

Benthic immatures have been found from Cape Cod, Massachusetts to southern Texas, and occasionally strand on beaches in northeastern Mexico. Large benthic immature loggerheads (70-91 cm) represent a large proportion of the strandings and in-water captures along the southern and western coasts of Florida as compared with the rest of the coast (Schroeder *et al*. 1998), but it is not known whether the larger animals are actually more abundant in these areas or just more abundant relative to smaller turtles. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish and vegetation at or near the surface (Dodd 1988). Sub-adult and adult loggerheads are primarily coastal and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

The TEWG (1998) considered nesting data collected from index nesting beaches to index the population size of loggerheads and to reflect trends in the size of the population. The TEWG constructed total estimates by considering a ratio between nesting data (and associated estimated number of adult females and therefore adults in nearshore waters), proportion of adults represented in the strandings, and in one method, aerial survey estimates. These two methods indicated that for the 1989–1995 period, there were averages of 224,321 or 234,355 benthic loggerheads, respectively. The TEWG listed the methods and assumptions in their report, and suggested that these numbers are likely underestimates. Aerial survey results suggest that loggerheads in U.S. waters are distributed in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

The TEWG report (1998) considered long-term index nesting beach data sets, when available, to identify trends in the loggerhead population. Overall, the TEWG determined that trends could be identified for two loggerhead subpopulations. The northern subpopulation appears to be stabilizing after a period of decline; the south Florida subpopulation appears to have shown significant increases over the last 25 years suggesting the population is recovering, although the trend could not be detected over the most recent 7 years of nesting. An increase in the numbers of adult loggerheads has been reported in recent years in Florida waters without a concomitant increase in benthic immature animals. These data may forecast limited recruitment to south

Florida nesting beaches in the future. Since loggerheads take approximately 20–30 years to mature, the effects of decline in immature loggerheads might not be apparent on nesting beaches for decades. Therefore, the TEWG report (1998) cautions against considering trends in nesting too optimistically.

Briefly, the TEWG report (1998) made a number of conclusions regarding the loggerhead population. The recovery goal of "measurable increases" for the south Florida subpopulation (south of Canaveral and including southwest Florida) appears to have been met, and this population appears to be stable or increasing. However, index nesting surveys have been done for too short a time; therefore, it is difficult to evaluate trends throughout the region. Recovery rates for the entire subpopulation cannot be determined with certainty at this time. Recently, NMFS convened a recovery team to update and revise the Atlantic recovery plan for loggerheads. The recovery team is conducting a full, independent review on the species biological and habitat requirements and re-evaluating appropriate recovery goals and recovery actions to meet those goals.

From a global perspective, the southeastern U.S. nesting aggregation is critical to the survival of the species. It is second in size only to nesting aggregations in the Arabian Sea off Oman and represents about 35-40% of the nests of this species. The status of the Oman nesting beaches has not been evaluated recently, but they are located in a part of the world that is vulnerable to extremely disruptive events (e.g. political upheavals, wars, and catastrophic oil spills), the resulting risk facing this nesting aggregation and these nesting beaches is cause for concern (Meylan et al. 1995).

Threats to loggerheads include domestic and international trawl, gillnet, hook and line, pelagic longline, fish trap, lobster pot, whelk pot, long-haul seine, and channel net fisheries, as well as non-fishery impacts like marine pollution, marine debris (e.g. ingestion of plastic; entanglement), harvest of eggs and adults in foreign countries, oil and gas extraction activities, development, transportation, underwater explosions, dredging, offshore artificial lighting, marina and dock construction and operation, boat collisions, and poaching (TEWG 1998; MMS 2002a). On their nesting beaches in the U.S., loggerhead turtles are threatened with beach erosion, armoring, and renourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; exotic dune and beach vegetation; poaching ; and predation by species such as fire ants, racoons (*Procyon lotor*), armadillos (*Dasypus novemcinctus*), and opossums (*Didelphus virginianus*). A more thorough description of anthropogenic mortality sources is provided in the TEWG reports (1998, 2000).

3.2.6.3 Fish

3.2.6.3.1 Gulf sturgeon (*Acipenser oxyrinchus desotoi*)

The NOAA Fisheries and US Fish and Wildlife Service (FWS) listed the Gulf sturgeon as a threatened species on September 30, 1991. NOAA Fisheries and FWS share jurisdiction for this species under the Endangered Species Act (NMFS 2001c, 2001f).

The Gulf sturgeon, *Acipenser oxyrinchus desotoi*, an anadromous species, officially known as the Gulf of Mexico sturgeon, is a subspecies of the Atlantic sturgeon (Vladykov 1955; Wooley 1985;USFWS 1994). The historic range of the Gulf sturgeon included nine major rivers and several smaller rivers from the Mississippi River, Louisiana, to the Suwannee River, Florida, and the marine waters of the Central and Eastern Gulf of Mexico, south to Tampa Bay (Wooley and Crateau 1985, USFWS 1995). The subspecies may also occur sporadically as far west as Texas, and in marine waters in Florida south to Florida Bay. While little is known about the abundance of Gulf sturgeon through most of its range, estimates exist for the Suwannee and Apalachicola rivers (NMFS 2001f). The USFWS reported an average of 115 individuals larger than 45 cm total length over-summering in the Apalachicola River below Jim Woodruff Lock and Dam. For the Suwannee River, population size estimates ranging from 2,250 to 3,300 individuals have been made.

Five genetically-based stocks have been identified by NOAA Fisheries and the USFWS: (1) Lake Pontchartrain and Pearl River, (2) Pascagoula River, (3) Escambia and Yellow rivers, (4) Chactawhatchee River, and (5) Apalachicola, Ochlockonee, and Suwannee rivers. Mitochondrial DNA analyses of individuals from sub-populations indicate that adults return to natal river areas for feeding as well as spawning (Stabile et al. 1996).

Subadult and adult Gulf sturgeon spend cool months (October or November through March or April) in estuarine areas, bays, or in the Gulf of Mexico (Odenkirk 1989, Clugston et al. 1995). Adult Gulf sturgeon likely overwinter in the Gulf of Mexico. Habitats used by Gulf sturgeon in the vicinity of the Mississippi Sound barrier islands tend to have a sand substrate and an average depth of 1.9 to 5.9 m (6.2 to 19.4 ft). Estuary and bay unvegetated "mud" habitats having a preponderance of natural silts and clays supporting Gulf sturgeon prey and the Gulf sturgeon found in these areas are assumed to be utilizing these habitats for foraging. Subadult and adult fish begin migration into rivers from the Gulf of Mexico in early spring (March) and continue until early May (Odenkirk 1989; Foster 1993; Clugston *et al*. 1995; Fox *et al*. 2000). In late September or October, subadult or adult sturgeon begin downstream migrations. Migration behavior may be influenced by water temperature and river flow rates (Chapman and Carr 1995; Foster and Clugston 1997). When not in river habitat, subadult and adult Gulf sturgeon occupy a variety of habitats in estuaries, bays, and the Gulf. Densities are high near the mouths of natal rivers. Sturgeon apparently only feed during their stay in marine waters; food items are rarely found in the stomachs of specimens sampled from rivers and an isotope ratio study also indicated that adults and subadults do not feed significantly in fresh water (Carr1983; Wooley and Crataeu 1985; Clugston *et al*. 1995; Morrow *et al*. 1998; Heise *et al*. 1999; Sulak and Clugston 1999; Ross *et al*. 2000; Gu *et al*. 2001). Adults and subadults feed on benthic invertebrates including amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, mollusks, and crustaceans (Huff 1975; Mason and Clugston 1993; Carr *et al*. 1996). Ghost shrimp (*Lepidophthalmus louisianensis*) and haustoriid amphipods (*Lepidactylus* spp.) are believed to be prime prey species (Fox *et al*. 2000; Heard *et al*. 2000). Juveniles are found widely dispersed in river systems around sandbars, shoals, and shallow areas (Randall and Sulak 1999). Juveniles eat aquatic insects, worms, and bivalves (Mason and Clugston 1993; Sulak and Clugston 1999).

Sulak and Clugston (1999) describe two hypotheses regarding where adult Gulf sturgeon may overwinter in the Gulf of Mexico to find abundant prey. The first hypothesis is that Gulf sturgeon spread along the coast in nearshore waters in depths less than 10 m (33 ft). The alternative hypothesis is that they migrate far offshore to the broad sedimentary plateau in deep water 40 to 100 m (131 to 328 ft) west of the Florida Middle Grounds. Available data support the first hypothesis. Evaluation of tagging data has identified several nearshore Gulf of Mexico feeding migrations, but no offshore Gulf of Mexico feeding migrations. Telemetry data document Gulf sturgeon from the Pearl River and Pascagoula River subpopulations migrate from their natal bay systems to Mississippi Sound and move along the barrier islands on both the barrier island passes (Ross et al. 2001a, Rogillio et al. in prep.). Gulf sturgeon from the Choctawhatchee River, Yellow River, and Apalachicola River have been documented migrating in the nearshore Gulf of Mexico waters between Pensacola and Apalachicola bay units (Fox et al. in press). Telemetry data from the Gulf of Mexico mainly show sturgeon in depths of 6 m (19.8 ft) or less (Ross et al. 2001a, Rogillio et al. in prep., Fox et al. in press).

Gulf sturgeon are long-lived, reaching an age of at least 42 years (Huff 1975). Age at sexual maturity for females ranges from 8 to 17 years, and for males from 7 to 21 years (Huff 1975). Adults spawn in the upper reaches of rivers, where demersal eggs sink and adhere to gravel/cobble bottoms (Vladykov 1963; Huff 1975; Wooley and Crateau 1985; Parauka *et al*. 1991; Ross *et al*. 2001b). Other potential spawning substrates include marl bottoms, soapstone, and hard clay. Water depths at egg collection sites ranged from 1.4 to 7.9 m (4.6 to 26'), with temperatures ranging from 18.3 to 22.0 degrees C. (Fox *et al*. 2000). A mature female may spawn 400,000 eggs, with at least a 1-year interval between spawns (Huff 1975; Chapman *et al*. 1993; Fox *et al*. 2000). Optimal larval survival occurs between 15-20 °C., and is poor above 25 °C. (Chapman and Carr 1995) Larvae are found among bedrock, clean gravel, or cobble substrates (Sulak and Clugston 1998). A few larval sturgeon have been collected in early April and early May in the Apalachicola River (Wooley *et al*. 1982). Early life history stages are sensitive to hypoxic conditions and high river flow rates (Secor and Niklitschek 2001; Wakeford 2001).

Habitat destruction and degradation, exacerbated by potential over-exploitation of the species, are primarily responsible for the sturgeon's decline. Dams have prevented access to historic sturgeon migration routes and spawning areas (Boschung 1976; Wooley and Crateau 1985; McDowell 1988). Dredging and other navigation maintenance, possibly including lowering of river elevations and elimination of deep holes and altered rock substrates, may have adversely affected Gulf sturgeon habitats (Wooley and Crateau 1985). Breeding populations take years to establish because of their advanced age at sexual maturity. In addition, Gulf sturgeon appear to be home-stream spawners with little natural repopulation from migrants from other rivers. Tagging studies suggest that Gulf sturgeon exhibit a high degree of river fidelity. From 1981 to 1993, 4,100 fish were tagged in the Apalachicola and Suwannee Rivers. Of these, 860 fish (21 percent) were recaptured in the river of their initial collection. Only eight subadults (.002 percent) moved between rivers (FWS *et al*. 1995). Foster and Clugston (1997) noted that telemetered Gulf sturgeon in the Suwannee River returned to the same areas as the previous summer, suggesting that chemical cueing may influence distribution.

The release of chemicals and other biological pollutants may destroy or adversely modify biologically important habitat for the Gulf sturgeon. The release of chemical or biological pollutants may alter water quality and sediment quality by affecting the following factors:

temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, such that it is appreciably impaired for normal Gulf sturgeon behavior, reproduction, growth, or viability.

Due to these habitat losses, and to comply with a court order, the USFWS and NOAA Fisheries have recently (February 28, 2003) listed 14 units of rivers, tributaries, estuarine and marine areas around the Gulf as 'critical habitat' for Gulf sturgeon. Under the Endangered Species Act (ESA) critical habitat refers to specific geographic areas that are essential for the conservation of a threatened or endangered species and that may require special management consideration or protection. Gulf sturgeon critical habitat was designated by final rule published on March 19, 2003 (68 FR 13370). Detailed description of the critical habitat units may be found in this document. Fourteen critical habitat unit descriptions have been designated for the Gulf sturgeon. NOAA Fisheries has critical habitat jurisdiction over the following estuarine and marine critical habitat units:

Portions of the following Gulf of Mexico rivers and tributaries are listed as critical habitat for Gulf sturgeon	
Unit 1	Pearl River System in St. Tammany and Washington Parishes in Louisiana and Walthall, Hancock, Pearl River, Marion, Lawrence, Simpson, Copiah, Hinds, Rankin, and Pike Counties in Mississippi
Unit 2	Pascagoula River System in Forrest, Perry, Greene, George, Jackson, Clarke, Jones, and Wayne Counties, Mississippi
Unit 3	Escambia River System in Santa Rosa and Escambia Counties, Florida and Escambia, Conecuh, and Covington Counties, Alabama
Unit 4	Yellow River System in Santa Rosa and Okaloosa Counties, Florida and Covington County, Alabama
Unit 5	Choctawhatchee River System in Holmes, Washington, and Walton Counties, Florida and Dale, Coffee, Geneva, and Houston Counties, Alabama
Unit 6	Apalachicola River System in Franklin, Gulf, Liberty, Calhoun, Jackson, and Gadsen Counties, Florida
Unit 7	Suwannee River System in Hamilton, Suwannee, Madison, Lafayette, Gilchrist, Levy, Dixie, and Columbia Counties, Florida
Portions of the following Gulf of Mexico estuarine and marine areas are listed as critical habitat for Gulf sturgeon. NOAA Fisheries has critical habitat jurisdiction over the following estuarine and marine critical habitat units:	
Unit 8	Lake Pontchartrain, Lake St. Catherine, The Rigolets, Little Lake, Lake Borgne, and Mississippi Sound in Jefferson, Orleans, St. Tammany, Jefferson, Orleans, and St. Bernard Parish, Louisiana, Hancock, Jackson, and Harrison Counties in Mississippi, and in Mobile County, Alabama
Unit 9	Pensacola Bay in Escambia and Santa Rosa Counties, Florida
Unit 10	Santa Rosa Sound in Escambia, Santa Rosa, and Okaloosa Counties, Florida
Unit 11	Florida Nearshore Gulf of Mexico waters in Escambia, Santa Rosa, Okaloosa, Walton, Bay, and Gulf Counties in Florida
Unit 12	Choctawhatchee Bay in Okaloosa and Walton Counties, Florida
Unit 13	Apalachicola Bay in Gulf and Franklin County, Florida
Unit 14	Suwannee Sound in Dixie and Levy Counties, Florida

Detailed information about Gulf sturgeon, including a link to the final rule and maps of the units identified above can be found by going to the web site http://endangered.fws.gov and from there navigating to the page providing Gulf sturgeon information.

3.2.6.3.2 Smalltooth sawfish (*Pristis pectinata*)

On April 1, 2003, NOAA Fisheries listed as endangered the U.S. population of smalltooth sawfish that once ranged in shallow waters off the Gulf of Mexico and Eastern Seaboard. An extensive status review has concluded that the U.S. population of smalltooth sawfish, currently found only off South Florida, is in danger of extinction (NMFS 2001a).

Sawfish, like sharks, skates and rays, belong to a class of fish called elasmobranchs, whose skeletons are made of cartilage (NMFS 2001b). Sawfish are actually modified rays with a shark-like body, and gill slits on their ventral side. Early sawfish arose around 100 million years ago, but these first sawfish are actually distant cousins to the modern day sawfishes, which first appeared around 56 million years ago. Sawfish get their name from their "saws" - long and flat snouts edged with pairs of teeth that are used to locate, injure, and incapacitate prey, which are then eaten. Their diet includes mostly smaller schooling fish like mullet and smaller herrings, but they also consume some crustaceans and other benthic animals (Bigelow and Schroeder 1953).

Smalltooth sawfish is one of two species of sawfish that inhabit U.S. waters, the other being the largetooth sawfish (*Pristis perotteti*) (NMFS 2001a). Smalltooth sawfish are about 2 feet long (0.6 m) at birth and commonly reach 18' (5.5 m) in length as adults, but may grow up to 25' (7 m) in length (Bigelow and Schroeder 1953). Individuals have been kept in public aquaria for up to 20 years. Although there are no detailed studies of smalltooth sawfish reproductive biology, it is thought to be similar to the better-studied largetooth sawfish.

Growth studies of largetooth sawfish indicate that sawfish are K-strategists, having a slow growth rate, long life span (30 years), and late age at maturity of about 10 years (Thorson 1982; Simpfendorfer 2000). As in all elasmobranchs, fertilization is internal. Sawfish are ovoviviparous, and gravid females have been found with 15-20 embryos (Bigelow and Schroeder 1953). Studies of largetooth sawfish in Lake Nicaragua reported litter sizes of 1-13 pups, with a mean of 7.3 pups per litter (Thorson 1976). The gestation period for largetooth sawfish is about 5 months and females are believed to produce litters every second year.

Sawfish species inhabit shallow coastal waters of tropical seas and estuaries throughout the world (NMFS 2001a). They are usually found in shallow waters, very close to shore around mangroves, seagrass beds, and over muddy and sandy bottoms. They are often found in sheltered bays, on shallow banks, in estuaries, and near channels, creeks and river mouths. Adults have occasionally been reported in deeper coastal waters. Certain species of sawfish are known to ascend inland in large river systems, and they are among the few elasmobranchs that are known from freshwater systems in many parts of the world. The lower thermal tolerance of 16-18 °C. may limit the distribution of this species both latitudinally and seasonally.

Smalltooth sawfish have been reported in both the Pacific and Atlantic Oceans, but the U.S. population is found only in the Atlantic (NMFS 2001a). In the western Atlantic, the smalltooth sawfish has been reported from Brazil through the Caribbean, the Gulf of Mexico, and the Atlantic coast of the United States. Historically, the U.S. population was common throughout the Gulf of Mexico from Texas to Florida, and along the east coast from Florida to Cape Hatteras. The current range of this species is now thought to be limited to the Florida coast from St. John's County in the Atlantic, extending southward throughout the Florida Keys, and northward along the Florida Gulf coast to Pinellas County. However, smalltooth sawfish are relatively common only in the Ten Thousand Islands and Everglades regions at the southern tip of the Florida. No accurate estimates of abundance trends over time are available for this species. However, available records, including museum records and anecdotal fisher observations, indicate that this species was once common throughout its historic range and that the smalltooth sawfish population has declined dramatically in U.S. waters over the last century.

Due to their K-selected strategy, recovery of the smalltooth sawfish population will be very slow, which makes this species vulnerable to even small changes to the population. Animals with low intrinsic rates of increase are particularly susceptible to excessive mortalities and rapid stock collapse, after which recovery may take many decades (Musick *et al*. 2000). For example, rapid stock collapses have been documented for many elasmobranchs shown to have low intrinsic rates of increase, particularly larger species (Musick *et al.* 2000). Sawfish are extremely vulnerable to overexploitation because of their propensity for entanglement in nets, their restricted habitat, and low rate of population growth (NMFS 2001a). The decline in smalltooth sawfish abundance has been caused primarily by bycatch in various fisheries, likely compounded by habitat degradation. In order to protect this species, the states of Florida and Louisiana have prohibited the take of sawfish. Three National Wildlife Refuges in Florida also protect their habitat.

Present threats to smalltooth sawfish include loss of coastal habitat resulting from increased urbanization of the southeastern coastal states from development, commercial activities, dredge and fill operations, recreational boating, erosion, and diversions of freshwater run-off (SAFMC 1998). Smalltooth sawfish may be especially vulnerable to coastal habitat degradation due to their affinity for shallow, estuarine systems.

3.2.6.3.3 Candidate list of managed species for protection

Candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act, but for which development of a listing regulation is precluded by other higher priority listing activities.

The Candidate Conservation Program provides a means for conserving these species. Early conservation preserves management options, minimizes the cost of recovery, and reduces the potential for restrictive land use policies in the future. Effective candidate conservation may reverse the species' decline, ultimately eliminating the need for ESA protection.

3.2.6.3.3.1 Goliath grouper *(Epinephelus itajara;* formerly known as Jewfish*)*

The Goliath grouper was added to the candidate species list in 1991 for the region of North Carolina and southward to the Gulf of Mexico, which encompasses the entire range of this species in U.S. waters (NMFS 2001e). At the time, it was still referred to as the Jewfish, but the American Fisheries Society has since changed the official name to Goliath grouper. Historically, Goliath grouper were found in tropical and subtropical waters of the Atlantic Ocean, both coasts of Florida, and from the Gulf of Mexico down to the coasts of Brazil and the Caribbean. Most adults are found in shallow waters, the deepest being about 46 m. Spawning occurs at aggregation sites during July through September over full moon phases. Fish may move up to 100 km from inshore reefs to the offshore spawning aggregations in numbers of up to 100 or more on ship wrecks, rock ledges, and isolated patch reefs along the southwest coast of Florida. Aggregations declined in the 1980s from 50-100 fish to less than 10 per site. Since the harvest prohibition, aggregations have rebounded somewhat to 20-40 fish per site. When Goliath grouper are not on their spawning aggregations, they are dispersed along shallow reefs. Historically, they were abundant in very shallow water, often associated with piers and jetties along the Florida Keys and southwest coast of Florida. They are no longer abundant in these shallow areas.

Juvenile Goliath grouper have been found along shallow mangrove shorelines underneath mangrove prop roots (NMFS 2001e). Their historical center of abundance is in the Ten Thousand Islands area of southwest Florida. Although Goliath grouper are very vulnerable to cold waters and red tide, they are one of the only groupers that can live in brackish waters. Fish taken from an exploited population were aged from 0-37 years, but it is likely that Goliath grouper live much longer than 40 years if left unexploited.

The most likely cause of drastic declines was the heavy fishing pressure on aggregations (NMFS 2001e). When large numbers of normally dispersed fish are concentrated at predictable areas and times, they are highly vulnerable to overexploitation. Fishing on spawning aggregations also removes many reproductive individuals before they have had the opportunity to spawn. Many Goliath grouper were caught between the ages of 9-15 years, meaning that individuals only lived through only a few reproductive years before being captured. Their long lives and large size at sexual maturation has made them especially susceptible to overfishing. Finally, genetic diversity can be impacted when the fishing mortality rate is greater than the natural mortality rate.

Quantitative data on fishing mortality rates and biomass levels are lacking. Goliath grouper are especially vulnerable to fishing due to their availability in aggregations and due to their low productivity. The fishery has been closed since 1990; consequently, fishing mortality rates are currently near zero.

3.2.6.3.3.2 Speckled hind *(Epinephelus drummondhayi)*

The speckled hind was added to the candidate species list in 1997 (NMFS 2001d). Speckled hind inhabit warm, moderately deep waters from North Carolina to Cuba, including Bermuda, the Bahamas and the Gulf of Mexico. Their preferred habitat is hard bottom reefs in depths ranging from 55 m to 110 m, where temperatures are from 60 to 85 degrees F.

Like other epinepheline groupers, speckled hind are protogynous hermaphrodites, which means they begin life as females and as they grow older they become males (NMFS 2001d). Most of the larger, older fish are males. Females reach sexual maturity around four to five years old. Spawning takes place offshore from July through September. The fertilized eggs are pelagic, and the newly hatched larvae are commonly found on the surface before migrating to the bottom. Speckled hind generally engulf their prey whole. The fish opens its mouth and extends the gill covers rapidly to draw in a current of water, thus inhaling the food. Groupers are also known to pursue their prey and strike it. Prey items for the speckled hind include: fishes, crabs, shrimps and mollusks that inhabit the hard bottom.

The major threat to the speckled hind is mortality as a result of fishing.

3.2.6.3.3.3 Nassau grouper *(Epinephelus striatus)*

The Nassau grouper was an addition to the 1991 candidate species list. It is a tropical western Atlantic serranid that is an extremely popular food fish, resulting in its declining status (NMFS 2001g). The Nassau grouper grows to about 100 cm (3') and 25 kg (55 lbs.). It is a top-level predator found from inshore to about 100 m. Adults are generally found near shallow high-relief coral reefs and rocky bottoms to a depth of at least 90m. This species is found in the Florida Keys, but is absent in most of the Gulf of Mexico where it is apparently replaced by red grouper (Sadovy and Eklund 1999).

Quantitative data on fishing mortality rates and biomass levels are lacking. Nassau grouper are especially vulnerable to fishing due to their availability in aggregations and due to their low productivity. The fishery has been closed in the Gulf of Mexico since 1997; consequently, fishing mortality rates are currently near zero. Gulf of Mexico Nassau Grouper are considered severely depleted due to lack of occurrence in sampling and catches prior to the harvest moratorium.

3.2.6.3.3.4 Warsaw grouper *(Epinephelus nigritus)*

The Warsaw grouper was added to the candidate list in 1997. It is a serranid species found on deep reefs in the southeastern U.S. It ranges from North Carolina to the Florida Keys, Caribbean, Gulf of Mexico, and northern coast of South America (FAO 1977). The major threat to Warsaw grouper is mortality due to fishing (Huntsman *et al*. 1999). These fish are long-lived and have a slow growth rate, growing to over 136 kg (300 pounds) and 230 cm (7.5') in length, and living as long as 41 years (Manooch and Mason 1987; Heemstra and Randall 1993; Parker and Mays 1998; Musick *et al*. 2000). Adults live on the continental shelf break at depths of 350 to 650 feet, in association with reef and hard bottoms. They prefer rough, rocky bottoms with high profiles such as steep cliffs and rocky ledges (Manooch and Mason 1987; Bullock and Smith 1991; Heemstra and Randall 1993; Parker and Mays 1998). Adults feed on crabs, shrimp, lobsters, and fish by swallowing them whole after ambush or short chases (Heemstra and Randall 1993). Early juveniles occur in shallow nearshore habitats and may enter bays, moving into deeper water as they grow (Lavett Smith 1971; Hardy 1978; Smith 1978).

Little is known of their reproductive activities, but they are thought to be late summer spawners, and eggs and larvae are presumed to be pelagic (Bullock and Smith 1991; Parker and Mays 1998; Richards 1999). These fish are protogynous hermaphrodites, starting out as females, but changing into males as they grow older. They are believed to become sexually mature at around 9 years (Parker and Mays 1998; Musick *et al*. 2000).

NMFS has designated this species as "overfished" as defined by the Magnuson-Stevens Act. Recreational fishers in the Gulf of Mexico are presently limited to landing only 1 fish/ vessel/trip.

3.2.6.4 Seabirds

Seabirds are a diverse group of avian species that spend much of their lives on or over saltwater. Some can live far from land for extended periods of time, coming back to coastal areas to breed and nest. Seabirds take prey from the sea through dipping, plunging, and surface seizing, as well as the behaviors of piracy and scavenging.

Three of the four primary orders of seabirds are represented in the Gulf of Mexico, Procellariiformes (petrels, albatrosses, and shearwaters), Pelecaniformes (pelicans, gannets and boobies, cormorants, tropic birds, and frigate birds), and Charadriiformes (phalaropes, gulls, terns, noddies, and skimmers) (Clapp *et al*. 1982; Harrison 1983). The orders Gaviiformes (loons) and Podicipediformes (grebes) are also found in the Gulf.

Species of seabirds and other coastal species that inhabit or frequent the northern Gulf of Mexico that are recognized by the U.S. Fish and Wildlife Service as either endangered or threatened include: piping plover, least tern, roseate tern, bald eagle, and brown pelican (the brown pelican is endangered in Mississippi, Louisiana, and Texas and de-listed in Florida and Alabama). Additionally, the southeastern snowy plover is a species of concern to the state of Florida.

The incidental catch of seabirds in various fisheries around the world has generated much concern over the long-term ecological effects during the past two decades. In particular, longline fishing is susceptible to seabird bycatch. The U.S. voluntarily developed a *National Plan of Action for reducing the Incidental Catch of Seabirds in Longline Fisheries* (NPOA-S) as requested in the *International Plan of Action for Reducing the Incidental Catch of seabirds in Longline Fisheries* (IPOA-S).

The brown pelican, *Pelecanus occidentalis* (Family: Pelicanidae), one of two pelican species in North America, has been listed as endangered since 1970 in its entire range, except that it is a delisted recovered taxon (and monitored for the first five years) in Alabama and Florida since 1985. Although not listed as endangered in Florida, it is listed as a species of special concern by the State.

Pelicans feed entirely upon fishes that it captures by plunge diving into coastal waters. They seldom venture to more than 20 miles out to sea except to take advantage of especially good fishing conditions, and even then it is rare to find one more than 40 miles out. Sand spits and offshore sandbars are used extensively as daily loafing and nocturnal roost areas. The preferred nesting sites are small coastal islands, which provide protection from mammal predators, especially raccoons, and sufficient elevation to prevent wide scale flooding of nests.

Primary factors affecting the eastern subspecies include human disturbance of nesting colonies and mortalities that result from the birds being caught on fishhooks and subsequently entangled in monofilament line. Oil or chemical spills, erosion, plant succession, hurricanes, storms, heavy tick infestations, and unpredictable food availability are other threats.

3.3 Human Environment

3.3.1 Description of the fisheries

The dockside value of the Gulf of Mexico commercial industry seafood production has tended to fluctuate in the $600 million to $800 million range. The most valuable commercially harvested species is shrimp, generally accounting for well in excess of one-half of the total. Other commercially important species (groups), to name just a few, include blue crabs, stone crabs, oysters, spiny lobsters, reef fish, coastal pelagics, and menhaden.

As stated in a 1996 National Marine Fisheries Service report entitled *Our Living Oceans: The Economic Status of U.S. Fisheries,* "[t]he most important factors influencing the economic performance of the commercial fishing industry in the Southeast Region (i.e., the Gulf of Mexico and South Atlantic) can be categorized as follows: (1) A major portion of the stocks are being harvested at less than their long term potential yield; (2) Most of the fisheries are overcapitalized in the sense that more harvesting effort than is necessary is employed to catch a given amount of the stock; (3) There are multiple, competing uses of the stocks, and these competing uses complicate management and raise the cost of management; (4) Most of the management regimes for the stocks feature controls, usually overall quotas, that have been successful in beginning to halt or reverse stock declines; (5) However, in most cases there are no overall controls on effort and a number of gear, trip limit, size, and other regulations tend to reduce harvesting efficiency and redistribute existing fish stocks with the result of increasing the costs of harvesting, management, enforcement, and monitoring; (6) From a marketing viewpoint, a number of stocks face market competition from imports of identical or similar species, and prices are often dictated not only by the supply of imported products but by the state of the world economy as well (p.81)."

The ensuing discussion attempts to analyze many of the Gulf of Mexico's commercial fisheries based on many of the factors considered above. For purposes of analysis, only the Federally managed Gulf fisheries are considered. In addition, since the EEZ has been closed to the harvesting of red drum, by both recreational and commercial fishermen, for more then a decade, this fishery is not considered. Fisheries that are examined include the spiny lobster fishery, the stone crab fishery, the shrimp fishery, the reef fish fishery, the coastal pelagic fishery, and coral.

3.3.1.1 Red Drum

The *Red Drum Fishery Management Plan* (RDFMP) was implemented in December, 1986. It prohibited the directed commercial harvest from the EEZ for 1987 and provided for a recreational bag limit of one fish per person per trip, and an incidental catch allowance for commercial net and shrimp fishermen.

The Gulf of Mexico Fishery Management Council prepared Amendment 1 to the RDFMP which was implemented in October, 1987. The amendment continued the prohibition of a directed commercial EEZ fishery and, due to high inshore fishing pressure, requested that all of the Gulf states implement rules within their jurisdictions that would provide for an escapement rate of juvenile fish to the SSB equivalent to 20 percent of those that would have escaped had there been no inshore fishery.

Since implementation of Amendment 2 in 1988, retention and possession of red drum from the EEZ has been prohibited. Catch and release activities by the recreational sector, however, are not prohibited. Hence, there is likely some recreational red drum fishing activity in Federal waters.

3.3.1.2 Reef fish

The Gulf of Mexico Reef Fish Fishery Management Plan (*RFFMP*) was one of the first FMP's developed by the Gulf of Mexico Fishery Management Council. It was submitted in August 1981 and approved by the Secretary of Commerce in June 1983. Implementation of the Plan was initiated in November 1984. Reef fish identified and managed under the original Plan included 14 species of snappers (*Lutianidae Family*), 15 species of groupers (*Serranidae Family*), and three species of sea basses *(Serranidae Family*). Subsequent Amendments to the Plan added five species of Tilefish (*Branchiostegidae Family*), two species of jacks (*Carangidae Family*), white grunt *(Haemulon plumieri*), Red porgy (*Pagrus pagrus*), and Gray triggerfish (*Balistes capriscus*).

The primary problem identified in the *RFFMP* was that "[a] substantial decline in reef fish stocks has occurred in some areas under jurisdiction of the Gulf of Mexico Fishery Management Council. A known factor contributing to this decline is overfishing in many areas of the Gulf of Mexico by directed recreational and commercial users. Other possible factors contributing to the decline are: (a) reduction in habitat, both natural and man-made, (b) a large bycatch in other fisheries, (c) major environmental changes (p. 22 Amendment 1 *RFFMP*)." In addition to this, another identified problem included "expanded competition between users competing for the resource and the space the resource occupies." As indicated, this expanded competition reflected, at least in part: (1) increasing fishing effort and the concentration of that effort in localized areas, (2) increasing fishing effort in other fisheries that have a bycatch of reef fish, (3) declining catch per unit effort in some areas, and (4) introduction of new gear.

The goal identified in the *RFFMP* was "[t]o manage the reef fish fishery of the United States waters of the Gulf of Mexico to attain the greatest overall benefit to the Nation with particular reference to food production and recreational opportunities on the basis of maximum sustainable yield as modified by relevant economic, social or ecological factors (p. 2)." Pursuant to this goal, some of the specific objectives in the RFFMP included (1) to rebuild the declining reef fish stocks wherever they occur within the fishery, (2) to conserve and increase reef fish habitats in appropriate areas and to provide protection for juveniles while protecting existing and new habitats, and (3) to minimize user conflicts between user groups of the resource and conflicts for space.

Since development of the *RFFMP*, a large number of Amendments have been implemented to achieve the goals and objectives set forth in the Plan and as modified in various Amendments.[21] Some of the primary actions taken via amendments are briefly outlined below.

Amendment 1 to the *RFFMP* was implemented in 1990. Among other actions taken, Amendment 1 established an 11.0 million pound commercial quota for grouper; subdivided into a 9.2 million pound shallow-water quota and a 1.8 million pound deep-water quota. The amendment also established a 3.1 million pound commercial red snapper quota. In addition, the Amendment implemented a framework procedure, referred to as a Regulatory Amendment, which allows for annual management changes (such as in TAC) without going through a Plan Amendment procedure (additional flexibility in the annual framework procedure for specifying TAC by allowing the target date for rebuilding an overfished stock to be changed depending on changes in scientific advice was established when Amendment 3 was implemented in July, 1991).

The first comprehensive attempt to curtail the expansion of effort in the commercial reef fish fishery of the Gulf of Mexico was enacted under Amendment 4 to the *RFFMP*. This Amendment, implemented in May 1992, established a maximum three-year moratorium on the issuance of new reef fish permits.[22] As identified in the *Problems Requiring Plan Amendment* Section of Amendment 4 (Section 3), "[t]he open access nature of the fishery has resulted in additional fishing effort or changes in the timing of existing effort in response to quotas and in response to actual or anticipated increases in stock levels. The additional effort and timing of the use of current effort both tend to dissipate the potential net benefits, which were originally forecast to result from the earlier management actions (p. 4)." The moratorium, which permitted the transfer of permits between vessels owned by an individual who is income qualifier or between individuals when a vessel is transferred, was instituted "to moderate short term future increases in fishing effort and to attempt to stabilize fishing mortality while the Council

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[21]For a complete history of management of the entire reef fish fishery, refer to Amendment 17, or Appendix A.

[22]With an increasing awareness of the overfished status of many of the reef fish stocks in throughout the Southeast U.S. (i.e., the Gulf and South Atlantic), particularly red snapper, the National Marine Fishery Service announced in November 1989 that after November 7, 1989, anyone entering the commercial reef fish fishery in the Gulf of Mexico or South Atlantic may not be assured of future access to the reef fish fishery. As such, the moratorium could have been made retroactive to November 7, 1989, based on the November 1989 announcement by the National Marine Fishery Service, the Council chose not to do so.

considers a more comprehensive effort limitation program (p. 4)." Amendment 4, one should recognize, was general in nature and did nothing to reduce the level of effort that was being directed at the red snapper fishery at the time of its enactment nor did it restrict the movement of fishing effort from vessels fishing reef fish into the red snapper fishery.[23]

Amendment 11, implemented in January 1996, extended the reef fish moratorium for no more than five years, or until 31 December 2000. It was extended again through Amendment 17 until 31 December 2005 unless replaced at an earlier date by a comprehensive controlled access system. Hence, as the discussion to present suggests, the commercial reef fish sector has been under a moratorium for a decade now and may remain under such a program in the foreseeable future.

In addition to considerations of a more comprehensive effort control program, the Council has addressed the reef fish trap fishery on several occasions. Amendment 5, implemented in February 1994, initiated a three-year moratorium on the use of fish traps by creating a fish trap endorsement and issuing the endorsement only to fishermen who had submitted logbook records of reef fish landings from fish traps. Amendment 14, while grandfathering in the existing fish trap endorsement holders (as of February 7, 1997) developed a ten-year phase out period of fish traps in the Gulf of Mexico. Furthermore, the amendment prohibited the use of fish traps west of Cape San Blas.

3.3.1.2.1 Aggregate reef fish poundage and value[24]

In aggregate, Gulf of Mexico commercial reef fish landings, averaging 21.8 million pounds annually, have exhibited no discernable long-term trend during the 1985-2001 period (Table 3.3.8). Overall, average annual landings of 21.6 million pounds during 1997-2001 were about five percent below the 23.0 million pounds reported annually during 1985-89. In addition to there being no significant trend, variability in aggregate landings is relatively minor with the highest production of 24.9 million pounds (1993) exceeding lowest reported landings of 19.6 million pounds (1998) by only about 25%. To some extent, the lack of variation reflects the large number of species included in the analysis. As one might expect, variability increases as individual species (families) are examined.

Florida (west coast) accounted for almost three-quarters the Gulf of Mexico aggregate commercial reef fish landings during the period of analysis (Table 3.3.9). Louisiana accounted for an additional 16% of the total while Texas represented 7%. Overall, there is little discernable

[23] At the time that Amendment 4 was being implemented, the majority of the Council's activities associated with the reef fish fishery were red snapper oriented. A detailed discussion of Council red snapper activities is presented in the next section.

[24] Unless otherwise noted, all poundage figures are expressed on a whole weight basis. In addition, as with other species discussed in this section of the report, poundage and value figures represent landings in the Gulf of Mexico as opposed to catch. Differences between landing figures and catch figures are addressed where relevant.

trend in landings by state with the exception that the shares represented by Alabama and Mississippi have fallen from the earlier years.

The value of the Gulf of Mexico aggregate commercial reef fish landings advanced from $36.8 million annually during 1985-89 to $41.9 million annually during 1997-2001; or by almost 15% (Table 3.3.8). Much of this increase is, of course, inflationary based. After removing inflation (1982-84 Consumer Price Index equal to the base period), the deflated value of landings fell by more than 20% (from $32.1 million annually to $24.9 million annually); far in excess of the five percent decline in poundage. The reduction in deflated value in excess of the reduction in change in poundage reflects, of course, a reduction in the deflated per pound price received for the harvested product at dockside. The deflated aggregate Gulf of Mexico commercial reef fish price, as indicated in Table 3.3.8, did decline substantially during the period of analysis. Specifically, the deflated price (unweighted) during 1985-89 equaled $1.40 per pound; almost 20% above the1997-2001 per pound price of $1.15.
Possible reasons for the decline in deflated dockside price are many and likely represent the confluence of a number of different factors. First, species (family) composition, each with differing dockside prices, may have changed during the period of analysis. Second, the demand for the Gulf of Mexico landed product may have declined, in aggregate, as a result of international (e.g., increased imports) or domestic (e.g., change in tastes and preferences) factors. Finally, supply shifts may have contributed to the reduction in aggregate dockside price. These factors are examined in greater detail below.

3.3.1.2.1.1 Production by family (groups) of species

Five families (groups) of species - groupers, snappers, tilefish, triggerfishes, and jacks- represent just less than 95% of the Gulf of Mexico aggregate reef fish landings (Table 3.3.10). Grouper landings, which averaged 10.6 million pounds annually during the 1985-2001 period, accounted for about one half of the aggregate reef fish landings. Snappers, with landings averaging 8.3 million pounds annually, represented an additional 38% of the total. Combined, tilefish and triggerfish, have represented from about two percent to about five percent of aggregate reef fish landings. Finally, jacks, which were not commercially harvested in the Gulf of Mexico until the 1990s, currently account for about five percent of aggregate landings. In general, with the exception of jacks, contributions to the aggregate by the different families (groups) in the Gulf of Mexico reef fish complex appear to have been relatively stable during the 1985-2001 period. This stability, as noted before, may be masked by changes in catches of individual species.

The dockside value of Gulf of Mexico grouper landings, as indicated in Table 3.3.11 averaged $22.1 million annually during 1997-2001 compared to $19.6 million annually during 1985-89. After adjusting for inflation, the value fell from an average of $17.1 million to $13.1 million (in 1982-84 prices); or by about 25%. The decline in the deflated dockside value of Gulf of Mexico snapper landings, from $12.9 million annually during 1985-89 to $10.3 million annually during 1997-2001, approximated 20%. The deflated dockside prices for both of these families (groups) declined significantly during the period of analysis.

There have been no recent published studies which evaluate those factors determining the Gulf of Mexico dockside grouper price and, as such, discussion of possible reasons for the observed decline in the deflated price is somewhat speculative. Given this caveat, however, it appears almost certain that increases in grouper imports, particularly fresh product, have contributed to the decline in the deflated dockside price. As reported by Antozzi (2001), imports of fresh grouper increased from 5.6 million pounds (product weight) in 1991 to 12.9 million pounds in 1998 before falling to 8.1 million pounds in 2000. The decline in grouper imports during 1999 and 2000 may reflect the increased domestic production during these two years (see Table 3.3.10), which mitigated the demand for imported product. Overall, more than 60% of U.S. imports of fresh grouper originate from Mexico with Panama accounting for most of the remaining imported product.

As was the situation with grouper, increases in snapper imports have almost certainly contributed to the decline in the deflated dockside price. Antozzi (2001) reported that fresh snapper imports advanced from less than eight million pounds in 1991 to almost 25 million pounds in 2000 while frozen snapper imports increased from two million pounds to five million pounds. While snapper import suppliers tend to be considerably more diverse than those for grouper, Mexico and Panama tend to be the largest exporters, on the basis of poundage. Significant exports also originate from a number of other countries in Central and South America.

In addition to the impact of increasing imports on domestic dockside snapper price, analysis by Waters (2001) indicates that the Gulf of Mexico Fishery Management Council's management regime for snapper, particularly red snapper, has also contributed to the decline in the deflated dockside snapper price. This will be examined in greater detail in the next section of the report.

Tilefish, triggerfish, and jacks tend to command significantly lower dockside prices than those observed for either groupers or snappers. In addition, the decline in deflated dockside prices that were observed for snappers and groupers are not apparent. To some extent, this may reflect the fact that markets were only recently developed for both triggerfish and jacks.

3.3.1.2.1.2 Production by individual species

Grouper species

Gulf of Mexico landings of six primary grouper species - red grouper, black grouper, gag grouper, yellowedge grouper, scamp, and snowy grouper - are presented in Table 3.3.12 for the 1986-2001 period.[25] These six groups have, in recent years, have accounted from about 95% to more than 98% of total reported Gulf of Mexico grouper landings.

Red grouper, as indicated by the information contained in Table 3.3.12, dominates grouper landings in the Gulf of Mexico. Landings of this species during the period of analysis have varied from less than five million pounds (1992 and 1998) to almost nine million pounds (1989).

[25]Identification of grouper by individual species was not initiated by the National Marine Fishery Service until 1986. Hence, it is not possible to include 1985 figures as has been customary throughout this section of the report.

Overall, average red grouper landings during the 1986-2001 period, equal to 6.4 million pounds annually, accounted for 60% of all Gulf of Mexico commercial grouper landings. Most of the red grouper fishery occurs within or immediately west of Florida's territorial sea (SEP Report, 1999). Given the dominance of red grouper in the aggregate grouper landings, the dockside price of red grouper closely mirrors that reported for the total (Table 3.3.11) though discounted by about five to ten cents per pound.

NOAA Fisheries, in October 2000, declared the red grouper stock to be overfished and undergoing overfishing. As noted in the Secretarial Amendment 1 to the RFFMP, such a designation requires that the Council submit to NOAA Fisheries a plan "to end overfishing and rebuild the stock to a level capable of sustaining MSY on a continuing basis. The stock should be rebuilt in as short of time as possible, but not to exceed 10 years...(p.9)."To achieve the required rebuilding schedule, a number of measures are proposed in the Secretarial Amendment 1 to the *RFFMP*.

Gulf of Mexico gag grouper landings increased from less than one-million pounds annually during the mid-to-late 1980s to more than two-million pounds annually by the late 1990s (Table 3.3.12). Confusion between gag and black grouper may have resulted in misidentification in earlier years, according to Schirripa and Goodyear (1994); hence, an underreporting of gag grouper in the earlier years.

Like red grouper, gag grouper is primarily harvested within or immediately west of Florida's territorial sea. Both red and gag grouper are generally caught in the same fishing grounds and by the same fishermen (SEP Report, 1999). Gag grouper dockside prices closely follow those reported for red grouper. As such, variations in the dockside price of gag grouper have tended to be inversely related to changes in the red grouper dockside price, rather than to changes in own landings (SEP Report, 1999).

As noted in the Secretarial Amendment 1 to the RFFMP, gag grouper are not considered overfished, nor are they undergoing overfishing based upon a 2001 stock assessment. Nonetheless, "...the gag fishing mortality rate is still in need of a reduction in order to reach the optimum yield level (p. 9).

Reported black grouper landings fell from more than one-million pounds annually during the mid-to-late 1980s to less than one-half million pounds annually in the later years of analysis. Some of the decline may be, as previously noted, the result of misidentification in earlier years. As was the case with gag grouper, black grouper prices tend to vary in relation (inversely) to red grouper landings.

Red grouper, gag grouper, and black grouper, when combined, comprise the vast majority of shallow water grouper landings. Yellowedge grouper and snowy grouper belong to the deep water complex. There appears to be no long-term trends in the harvest of these two species.

Snapper Species

Red Snapper: Red snapper is the primary snapper species landed in the Gulf (Table 3.3.13). It has also been, until recently, the focus of much of the attention by the Gulf Council with respect to the *RFFMP*. The management history of this species is provided by Waters (2001) and some of the relevant features are reviewed here.

The GMFMC, through Amendment 1 to the *RFFMP*, which was implemented in January 1990, established a 3.1 million pound quota for the commercial harvest of red snapper in the Gulf. In addition, the Amendment implemented a framework procedure, referred to as a Regulatory Amendment, which allows for management changes (such as TAC) without going through a Plan Amendment procedure.

The first Regulatory Amendment to the *RFFMP* was implemented in 1991. It set the red snapper TAC at 4.0 million pounds with 2.04 million pounds of the total being allocated to the commercial sector with the remainder being allocated to the recreational sector.

The 1990 commercial quota of 3.1 million pounds did not prove to be a binding constraint on the commercial harvest for that year which totaled 2.7 million pounds (Table 3.3.13) and the fishery remained open during the entire year. The 2.04 million pound quota established for the 1991 year, however, was achieved before the end of the year and the fishery was closed to commercial activities in mid-August, after 235 days of permitted fishing activities. The final commercial catch for the year equaled 2.24 million pounds (Table 3.3.13), or about 10% above that permitted under the quota.

Given an increasing stock abundance and an accelerated harvesting rush, the 1992 quota of 2.04 million pounds was reached after only 53 days, resulting in a closure of the commercial season in February. To alleviate economic and social disruptions that occurred as a result of the shortened season, the commercial red snapper season was reopened in April 1992 by an emergency rule implemented by NMFS at the request of the Council. This emergency rule, which extended through May 12, 1992, limited commercial of red snapper to 1000 pounds per trip and resulted in an additional harvest of about 600,000 pounds.

It was at this time that the first comprehensive attempt to curtail the expansion of effort in the reef fish fishery, as previously discussed, was enacted under Amendment 4. The GMFMC, recognizing the limitations afforded to it by the reef fish moratorium, in September 1992, requested NOAA Fisheries to implement a series of measures to extend the commercial red snapper season by emergency action.[26] The major provision of the emergency action was to establish a red snapper endorsement for qualified reef fish permittees to qualify for an endorsement, these people were required to demonstrate they had caught 5,000 pounds of red snapper landings in two of the three years, 1990-1992. Permitted vessels with this endorsement were allowed a 2,000 pounds of red snapper per trip.

The purpose of the trip limit was to forestall the recurrence of the 1992 derby fishery situation. The red snapper TAC for 1993, established under a Regulatory Amendment, was set at 6.0 million pounds with 3.06 million pounds of the total allocated to the commercial sector, managed under quota. The opening of the 1993 commercial red snapper season was delayed until mid-

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[26]This section draws heavily on, and is often quoted directly from, Amendment 6 to the *RFFMP*.

February to allow NOAA Fisheries sufficient time to process and issue the endorsements. The emergency action, initially effective for 90 days, was extended for an additional 90 days with the concurrence of NOAA Fisheries and the Council. Despite the reef fish vessel moratorium and red snapper endorsement system, the 1993 quota of 3.06 million pounds was met in 95 days. When the fishery was finally closed in May, the actual harvest totaled 3.41 million pounds.

To provide the Council with the time needed to develop a comprehensive effort management program, Amendment 6, which was implemented in June 1993, extended the provisions of the emergency rule through 1994. The commercial red snapper season, which opened on 10 February, lasted for 78 days. When closed in April, total catch was 3.25 million pounds.

A comprehensive effort management program as originally proposed was to be implemented in the Gulf red snapper fishery by early 1995. Due to Council delays in selecting and implementing such a program, however, the endorsement system was extended through 1995. The season, which opened in February, lasted for 51 days and when closed in April, the commercial catch had reached about 3 million pounds.

The 1996 commercial red snapper season, managed under a continuation of the endorsement system, was to open in February under an interim 1.0 million pound quota until the end of March. An ITQ system was to become operational in April, 1996. Because of the furlough of NMFS employees in December 1995 and a continuing resolution that provided budget funds for the Department of Commerce, however, NOAA Fisheries was unable to complete the work needed prior to implementation of the ITQ program. The program was originally suspended for 90 days with a provision for another 90 days if needed. Shortly thereafter, Congress, in its re-authorization of the M-S Act, placed a moratorium on all new ITQ programs in the U.S. and retroactive dates on the moratorium that would exclude the GMFMC from implementing any red snapper ITQ program.

Because of the pending moratorium on ITQs, the Council, in 1995, developed and submitted to NOAA Fisheries Amendment 13 which, among other things, extended the red snapper endorsement system through 1997. Amendment 15, implemented in 1998, formalized the two tier trip system in conjunction with the license limitation system. A total of 134 vessels were granted Class 1 status which permitted them to harvest 2,000 pounds of red snapper per trip when the fishery was open to commercial activities. Another 579 vessels were afforded Class 2 status which allowed them land 200 pounds of red snapper per trip when the season was open.

This rather extended analysis of the red snapper management history was presented to serve several purposes. First, it helps to explain why the management regime, currently in place, was initially established. The red snapper fishery is the only fishery under the auspice of the GMFMC in which commercial trip limits and a multi-tiered system are established. In fact, it is the only fishery for which commercial trip limits exist.

A second reason for presenting the management history of the fishery is that it helps to explain how the derby situation initially developed. As stated by Waters (2001), '[t]he current method of managing the commercial red snapper fishery with annual quotas has created a fishing derby in which fishermen fish as quickly as possible before the quota is filled and the season is closed, because those who wait may end up with smaller shares of the overall quota (p. 75)."

Analysis by Waters (2001) also suggests that the large quantities of fish being harvested and sold in a short period of time has resulted in market disruptions and significant decline in dockside price. Overall, the deflated dockside red snapper price prior to the derby situation (i.e., 1985-91) consistently fell in the range of $1.86 to $1.92 per pound. Since 1992, the high price received in any given year was $1.34 per pound and in one year the price was less then $1.10 per pound. Overall, Waters suggests that revenues earned by red snapper fishermen may have been twice that observed under a rationale effort management system (i.e., ITQ system) when compared to the current quota system.

Vermillion Snapper: It is generally felt that vermillion snapper served as a substitute for red snapper by reef fish fishermen. This factor likely accounts for at least a portion of the increase in vermilion snapper landings during the early-to-mid 1990s as restrictions being placed on commercial red snapper fishing activities were enhanced. While difficult to document, some of the recent decline in commercial vermillion snapper landings may reflect switching behavior among red snapper fishermen as the red snapper TAC increased.

Yellowtail snapper: Reported commercial landings of yellowtail snapper generally fall in the one million to two million pound range (Table 3.3.14). With few exceptions, landings of yellowtail snapper generally comprise less than ten percent of total Gulf of Mexico commercial snapper landings.

3.3.1.2.2 Effort and participation

Table 3.3.14, based on logbook data for the 1993-2001 period, shows snapper and/or grouper trips by grid and by gear. For example, it states that an average of 701 trips were reported annually in grid 1 (i.e., the Florida Keys) in which the harvest of snapper and/or grouper was reported. Handlines accounted for 90% of the total trips. Note: the percentages do not add up to 100 because not all gears are included. This is primarily spear fishing in the Keys.

Tables 3.3.15 and 3.3.16 provide similar information to that contained in Table 3.3.14 with the exception that grouper and snapper are treated separately. Handlines, as indicated, reflect the predominant gear in both fisheries.

Two gears, handlines and longlines, account for the majority of grouper landings (Table 3.3.17). Overall, the number of trips where grouper was caught using handlines averaged approximately 7,650 annually during 1993-2001 while annual grouper poundage produced from this gear fluctuated from less than 2.5 million pounds (1993) to more than 4.5 million pounds (2001). The majority of snapper catch is taken with handlines (Table 3.3.18).

The number of trips reporting the harvest of grouper using longlines, averaging 1,661 annually during 1993-2001, is relatively small when compared to handlines (Table 3.3.17). However, annual catch of grouper by the use of longline generally exceeds that of handlines by 30% to 50%. This differential reflects the significantly higher catch per trip for longline trips when compared to handline trips (Table 3.3.17).

Trips reporting the catch of grouper with traps fell sharply during the 1993-2001 period (Table 3.3.17). This reduction likely reflects the ten-year phaseout of traps, initiated in 1997, and the prohibition of trap fishing west of Cape San Blas (Amendment 14 *RFFMP*).

Snappers are predominately harvested with handlines (Table 3.3.18). During 1993-2001 trips reporting the catch of snapper with handlines averaged 9,164 annually while catch by handlines averaged 6.8 million pounds annually. Snapper catch by handline gear ranged from less than 600 pounds per trip in 1993 to more than 800 pounds during the three-year period ending in 1999.

While more than 800 longline trips each year report the catch of snappers (Table 3.3.18), total catch of snapper by longline gear is relatively minor, averaging just 200,000 pounds per year. This harvest is likely the product of joint production on longline trips where grouper is the targeted species.

As with grouper, trips reporting the catch of snapper by traps has fallen sharply in recent years as has the total snapper catch by traps (Table 3.3.18). Like grouper, this reduction likely reflects the ongoing phaseout of the trap fishery as well as the prohibition of traps west of Cape San Blas.

Maps depicting commercial fishing effort in the Gulf for reef fish handlines, reef fish bottom longlines, fish traps, spear fishing, and powerhead fishing are shown in Figures 3.3.2 through 3.3.6. The West Florida shelf is the area with the highest level of effort for these gears.

3.3.1.3 Coastal Pelagics

The fishery management plan for coastal migratory pelagic fisheries (king mackerel, Spanish mackerel, and cobia), prepared cooperatively by the Gulf of Mexico and South Atlantic Fishery Management Councils, was implemented in February 1983. The plan (*CPFMP)* was developed in response to a large number of problems identified in the fishery. These problems included the following (Amendment 1 to the *CPFMP*): First, it was recognized that fishing effort was jeopardizing the biological integrity of the king mackerel fishery. The second problem identified in the plan was that adequate management had been hindered by lack of current and accurate biological and statistical and economic information. Third, it was recognized that there was intense conflicts and that competition existed between recreational and commercial users of the mackerel stocks; and between commercial users employing different gears. The fourth problem identified was that the existence of separate state and Federal jurisdiction and lack of coordination between the two made biological management difficult, since in some instances, the resource may be fished beyond the location in state waters. The fifth identified problem was that cobia was being harvested at a size below that necessary and that it may have been overfished in some areas beyond the management area. The final problem identified during the planning process was that development of a fishery targeting large, mature king mackerel in the wintertime off Louisiana may eventually reduce recruitment to the resource.

To adequately address these concerns, the *CPFMP* identified four primary objectives. The first was to stabilize yield at MSY, allow recovery of overfished populations and maintain population levels sufficient to ensure adequate recruitment. The second objective was to provide a flexible management system for the resource which minimizes regulatory delay while retaining substantial Council and public input into management decisions and which can rapidly adapt to changes in resource abundance, new scientific information, and changes in fishing patterns among user groups or by area. The third objective was to provide necessary information for effective management and establish a mandatory statistical reporting system for monitoring catch. The final objective set forth in the *CPFMP* was to minimize gear and user conflicts.

Since its implementation, the *CPFMP* has been amended numerous times and there have been some changes (additions) to identified problems as well as objectives. Two of the more relevant objectives added (Amendment 5 and Amendment 6 to the *CPFMP)* include (1) to minimize waste and bycatch in the fishery and (2) to optimize the social and economic benefits of the coastal migratory pelagic fishery. The rationale for this last objective was to provide a goal to enhance economic benefits to all groups.

While detailed analysis of the amendments are beyond the scope of this document, there are a number of salient features addressed in these amendments that merit some attention. First, many of the amendments were enacted in response to allocation and/or gear issues. For example, Amendment 2 prohibited the use of purse seines on overfished stocks. Amendment 3, which was approved in 1990, prohibited drift gill nets for coastal pelagics and purse seines for the overfished groups of mackerels.[27] Amendment 5 further refined gear usage by requiring that the Gulf group of king mackerel could only be taken by hook-and-line or with run-around gill nets. Amendment 7 to the *CPFMP* also addressed an allocation issue. Specifically, as a result of conflicts in the commercial sector, the Amendment provided for a suballocation of the Eastern Zone Gulf migratory group of king mackerel commercial quota at the Dade/Monroe County line and further suballocated within these two areas between net and hook-and-line fishermen. Additional suballocations within the commercial component of the industry were established in Amendment 9 (both area and gear allocations).

In addition to allocation issues, many of the amendments focused on the revision (setting) of TAC and overfishing issues. Amendment 2, for example, set commercial quotas for mackerels. Amendment 6 provided for the rebuilding of overfished stocks of mackerels within specified time periods.

Though direct control of effort was not seriously considered when the *CPFMP* was first developed, more attention has been given to this issue over time. While the permit process was established under Amendment 1 to the *CPFMF*, income requirements were relatively lax; proof that a minimum of ten percent of earned income was derived from commercial fishing activities. The somewhat unrestrictive criteria established under Amendment 1 would suggest that it had only a minor impact on restricting effort. The prohibition of purse seines on overfished stocks

[27] There was considerable debate as to whether this action reflected a pure allocation issue or an attempt to prevent/arrest overfishing. The reader is referred to the *Resubmission of Disapproved Measures to Amendment 3 of the CPFMP* for a discussion of the issue.

(Amendment 2) was an additional attempt to limit commercial effort though, as noted, the action was treated primarily as an allocation issue. Furthermore, the action only limited effort in one small segment of the commercial fishing sector. The first all-inclusive attempt to restrict effort in the commercial sector can be traced to Amendment 8. As noted in the amendment, the number of commercial vessel permits for mackerel had doubled between 1987-88 and 1993-94 fishing seasons, from 1,280 to 2,588 and in 1997-98 equaled 2,754. As noted in Amendment 8, available effort exceeded that needed to optimally harvest available TAC

In response to the excessive and expanding level of effort, Amendment 8 established a moratorium on all commercial king mackerel permits until no later than October 15, 2000 with a qualification date for initial participation of October 16,1995. In addition, it increased the income requirement for a king or Spanish mackerel permit to 25% of earned income or $10,000 from commercial sale of catch or charter or head boat fishing in one of the three previous years. The purpose of this moratorium was to provide stability and prevent speculative entry into the fishery while the Councils developed a limited access or limited entry program. The amendment was also intended to reduce overfishing of the Gulf group king mackerel and aid in the recovery of the stock. As a result of a number of factors, including the moratorium that prohibited Councils from submitting management plans or amendments that would create IFQ's until October 1, 2000, the Council realized that it would not be able to develop and implement a comprehensive limited access or limited entry program prior to the expiration of the moratorium on all commercial king mackerel permits (i.e., October 15, 2000). If the moratorium were to expire prior to additional action being taken, the fishery would revert to an open-access system. To prevent this from occurring, the Council extended the moratorium in Amendment 12.

As noted, Amendment 6 to the *CPFMP* added an objective to optimize the social and economic benefits of the coastal migratory pelagic fisheries. One can certainly appreciate the problems associated with optimizing either the social or economic benefits. To optimize both simultaneously is, except in some possible rare occasion, impossible. A brief review of the amendments would tend to indicate that social considerations (particularly the numerous suballocations by regions and gears and the prohibition of certain gears) have outweighed economic considerations by a considerable margin. Furthermore, it is unlikely that any significant increases in economic benefits will be forthcoming until such time that a comprehensive effort management system is implemented and only then if the potential benefits derived therefrom exceed costs.

3.3.1.3.1 Poundage and Value

Three species - king mackerel, Spanish mackerel, and cobia - are considered in the coastal pelagic fishery. Landings of these three species, as indicated from the information contained in Table 3.3.19, have fallen sharply in recent years; particularly after 1994. A large proportion of the total coastal pelagic landings have historically been Florida based but Louisiana, in recent years, has taken a larger share of the total (Table 3.3.20).

The reason for the decline in coastal pelagic landings relates, at least to some extent, to gear restrictions. The citizens of the state of Florida passed a referendum prohibiting certain types of fish nets to be used in state waters. The "Florida net ban," as it is commonly referred to, went into effect on July 1, 1995. Nets conducive to the harvesting of Spanish mackerel were prohibited at this point in time. Spanish mackerel landing fell sharply in 1995 and have remained relatively low, in relation to earlier years, thereafter (Table 3.3.21)[28]. Overall, the proportion of coastal pelagic landings represented by Spanish mackerel fell from more than 50% prior to 1995 to less than 30%, on average, after 1995.

While illustrating a significant amount of variation on a year-to-year basis, Gulf of Mexico commercial production of king mackerel has remained relatively stable during the period of analysis (Table 3.3.21). This stability, to some extent, likely reflects the annual quotas placed on the commercial sector. Like Spanish mackerel, the majority of commercial king mackerel activities are Florida based though significant harvests are also reported for Louisiana in some years.

Commercial harvest of cobia, as indicated by the information in Table 3.3.21, comprises a relatively minor portion of coastal pelagic activities. Landings during the period of analysis were generally less than 250,000 pounds and accounted for significantly less than ten percent of total commercial coastal pelagic activities; measured on the basis of pounds.

The annual value of coastal pelagic harvests generally falls in the relatively narrow range of $2.5 million to about $4.0 million (Table 3.3.19). On a deflated basis, the value of coastal migratory pelagic landings have experienced no growth due to a combination of little growth in the deflated per pound price and a decline in pounds landed; the result of Spanish mackerel.

When examined on a species basis, the deflated value of king mackerel landings has exhibited no long-term trend and the deflated price of the harvested product has exhibited a long-run downward trend (Table 3.3.22). Despite the sharp reduction in Spanish mackerel landings associated with the 1995 Florida net ban (Table 3.3.21), the deflated dockside price showed no significant positive response (Table 3.3.22). Reportedly, this is the result of market disruptions associated with having insufficient supplies of Spanish mackerel needed to meet the historical demands in the traditional markets where the product had historically been sold prior to the ban.

3.3.1.3.2 Effort and Participation

As indicated in Amendment 12 to the *CPFMP*, the number of commercial vessel permits for mackerel in 1997-98 equaled 2,754 compared to 2,588 during the 1993-94 year. In the amendment, it was also argued that most, if not all, of the vessels with mackerel permits in the fishing year 1997-98 targeted king mackerel at least during part of the season.

As indicated in Table 3.3.23, with few exceptions, handlines account for the majority of coastal

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[28] The reduction in Spanish mackerels likely reflects two concomitant factors. First, the prohibition of gill nets in Florida waters, the primary Spanish mackerel producing region, resulted in a restriction of the most efficient harvesting gear. Alternative gears, being inefficient relative to the gill net, resulted in higher costs per unit effort. Second, the reduction in poundage also reportedly resulted in a disruption in markets. This, in turn, resulted in a price reduction for the harvested product.

pelagic trips, by grid. There are relatively high catches of coastal pelagics reported from many of the grids throughout the Gulf of Mexico, though several areas show particularly high catches.

A map depicting coastal pelagics commercial handline effort is shown in Figure 3.3.7. The heaviest fishing effort occurs off western Louisiana, the Mississippi delta, and the Florida Keys.

3.3.1.4 Shrimp

The Gulf of Mexico shrimp fleet generates more than $400 million annually, or about 60% of the total revenues derived by the region's entire commercial fishery. These revenues, however, come with direct and indirect costs to society. Given that the shrimp industry is overcapitalized from an economic perspective, the direct costs of harvesting (e.g., fuel, labor, and capital) are higher then would be the case if under a more economically rational management program. Costs also arise from the incidental bycatch caused by traditional shrimp harvesting techniques. The bycatch costs are often market oriented, as when they contribute to the overfished status of the Gulf red snapper stock and lower stock levels of other commercial and recreational species. Bycatch costs, however, may also be nonmarket oriented, as when harvesting techniques affect endangered species such as marine turtles. Finally, there is increased concern that traditional trawling techniques can result in habitat degradation in areas of the Gulf susceptible to heavy fishing pressure, thereby generating additional costs associated with habitat degradation.

Shrimp species common to the Gulf of Mexico tend to be short-lived animals and annual harvests can vary significantly (Garcia, 1984).[29] The large variations in landings are primarily environmentally induced with changes in salinity, water temperature, etc. during the shrimp's growth cycle all contributing to annual variation in both the number and average size of shrimp caught (Rothschild and Brunenmeister, 1984).

Given their short-lived nature, it is generally believed that Gulf shrimp species are, from a biological perspective, resistant to overfishing (Poffenberger, 1984). The fishery, however, is operating at its maximum potential in terms of yield, and the amount of effort used to achieve this maximum is excessive due to the common property nature of the fishery (Blomo, 1981).[30] Thus, even though effort expanded significantly from the 1970s through the mid-1980s, catch remained relatively constant. Furthermore, Browder *et al*. (1989) have provided information that suggests that changes in shrimp catch in certain areas of the Gulf are the result of deterioration of coastal wetlands which has provided increased shrimp habitat. The authors suggest that shrimp catch will fall sharply as the interface between land and water peaks and then falls.

It was within the context of this background that the *Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters* (*SFMP)* was implemented as a Federal regulation in 1981. As noted in the *History of Management Section* of Amendment 11, principle actions taken

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[29]The primary exception to this generalization is that of Royal Red shrimp which can live for several years.

[30]Though more than 20 years old, the discussion presented by Blomo is still valid with the exception that Texas has implemented a limited entry program for the inshore fishery.

at the time included: (1) establishment of a cooperative Tortugas Shrimp Sanctuary with the state of Florida; (2) a cooperative seasonal closure with the state of Texas; and (3) seasonal zoning of an area of Florida Bay for either shrimp or stone crab fishing to avoid gear conflicts.

Problems identified in the *SFMP* which led to such actions being taken included the following: (1) Conflict among user groups as to area and size at which shrimp are harvested; (2) Discard of shrimp through the wasteful practice of culling; (3) The continuing decline in the quality and quantity of estuarine and associated inland habitats; (4) Lack of a comprehensive, coordinated and easily ascertainable management authorities over shrimp resources throughout their ranges; (5) Conflicts with other fisheries such as the stone crab fishery in southern Florida, the groundfish fishery of the north central Gulf, and the Gulf's reef fish fishery; (6) Incidental capture of sea turtles; (7) Loss of gear and trawling grounds due to man-made underwater obstructions; and (8) Partial lack of basic data needed for management.

The goal of the *SFMP* is to manage the shrimp fishery of the United States waters of the Gulf of Mexico in order to attain the greatest overall benefits to the nation with particular reference to food production and recreational opportunities on the basis of the maximum sustainable yield as modified by relevant economic, social or ecological factors. To achieve this goal, the following objectives were specified: (1) Optimize the yield of shrimp recruited to the fishery; (2) Encourage habitat protection measures to prevent undue loss of shrimp habitat; (3) Coordinate the development of shrimp management measures by the GMFMC with shrimp management programs of the several states, where feasible; (4) promote consistency with the Endangered Species Act and the Marine Mammal Protection Act; (5) Minimize the incidental capture of finfish by shrimpers, where appropriate; (6) Minimize conflicts between shrimp and stone crab fishermen; (7) Minimize adverse effects of underwater obstructions to shrimp trawling; and (8) Provide for a statistical reporting system.

The *SFMP* has been amended several times since its implementation. As a result of new problems recognized in the fishery, Amendment 4, which was finalized in 1989, revised the objectives of the *SFMP* accordingly. New problems recognized included: (1) Increasing catch of small shrimp in inshore waters; (2) Pulse fishing resulting from seasonal closure; (3) Loss of access to productive shrimp fishing grounds off Mexico; (4) Possible loss of shrimp to Mexico through transboundary migration; (5) Competition in shrimp sizes targeted by management with prevalent sizes produced by foreign mariculture operations; (6) Inconsistency in some state and Federal regulations; (7) Excessive fishing effort employed in the fishery; and (8) Limited enforcement capabilities.[31] Objective 7 in the original FMP was expanded to minimize adverse effects of obstructions to shrimp trawling.

Amendment 9 was, one might speculate, the most controversial amendment to the *SFMP*. The amendment, approved in May 1998, required the use of a NMFS certified bycatch reduction devices (BRD's) in shrimp trawls used in the EEZ from Cape San Blas, Florida to the

[31]One former objective regarding the lack of comprehensive, coordinated, and easily ascertainable management authorities was deleted in Amendment 4.

Texas/Mexico border. The purpose of this action was to reduce the bycatch mortality of juvenile red snapper.[32]

Though controversial, the mandating of BRD's paled in relation to Turtle Excluder Device (TED) requirements. These devices were developed to comply with the requirements of the Endangered Species Act. The requirement that TED's be used in shrimp trawls fished in offshore waters was first initiated in 1989. Since it involved the Endangered Species Act, the Council did not have an active role in development of the TED program.

In the following sections, a brief review of the Gulf of Mexico shrimp fishery is presented. With few exceptions, the time frame for analysis covers the 1985-2001 period.

3.3.1.4.1 Poundage

3.3.1.4.1.1 Production from offshore and inshore waters

Shrimp production from the Gulf of Mexico traditionally fluctuates in the 120 million to 160 million pound range (heads off weight), though production in excess of 170 million pounds has been observed (Table 3.3.4). In general, there is no discernable trend in the production of shrimp from Gulf waters since 1985.

The harvest from offshore waters generally represents about 70% of the total Gulf shrimp landings. While annual harvests from these waters have fluctuated from less than 75 million pounds to more than 110 million pounds, as with total production, no long term trend in production from offshore waters is readily apparent when considering data from 1985 to present (Table 3.3.4).

While there are some exceptions to the rule, offshore harvesting activities are generally conducted by larger vessels; some in excess of 100 feet in length. The larger freezer boats can remain out-at-sea for more than a month at a time. These vessels are almost exclusively quad rigged and often traverse wide sections of the Gulf waters on any given trip.

Shrimp harvests from inshore waters tend to be made by smaller vessels (often non Coast Guard documented; i.e., less than five net tons) and trips by these vessels are often one-day trips but can, in some instances, last up to about a week. Production from inshore waters during the 1985-2001 period fluctuated from less than 40 million pounds (heads-off weight) to more than 60 million pounds and averaged 50 million pounds (Table 3.3.4).

Shrimp fishing in the Gulf is predominantly trawl oriented (Table 3.3.4). Prior to 1991, more than 95% of the total landings were reportedly taken by trawls. Since the early 1990s, however, the domination of harvest by trawls has apparently lessened. Since 2000, in fact, only about 80%

[32] Amendment 11 would, if approved, expand the mandatory use of BRD's throughout the entire range of the Gulf shrimp fishery in the EEZ.

of the total harvest has reportedly been derived from trawl gear.[33]

Offshore shrimping activities are almost exclusively trawl based (Table 3.3.4); indicating that any change in catch composition by gear type is occurring in the inshore waters. Overall, the percentage of catch taken by trawls in inshore waters has tended in decline steadily since the mid 1980s when it averaged over 90%. By the late 1990s, the percentage of inshore catch derived from trawling activities had fallen to about 75% and averaged just slightly above 50% in 2000 and 2001. Some of this most recent decline, however, may primarily reflect a change in data collection techniques as opposed to an actual change in the type of gears used.

Wing nets (butterfly nets) and skimmers represent the primary gears used, other than trawls, in inshore waters. These gears, which are extremely efficient in the harvest of shrimp under optimal conditions (primarily tide and moon phase), are employed primarily in Louisiana, which accounts for a large proportion of inshore Gulf shrimp catch.

3.3.1.4.1.2 Production by species

While there are four species of shrimp in the *SFMP*, two species - brown and white - account for more than 90% of the region's annual production. Brown shrimp catches tend to exceed white shrimp catches by about 30 million pounds per year, though differences approaching or exceeding the 40 million pound mark are not uncommon (Tables 3.3.5).

Brown shrimp landings averaged 83 million pounds (heads off) annually during 1985-2001 and fluctuated from less than 70 million pounds to more than 100 million pounds (Table 3.3.5). Production of brown shrimp from offshore waters, which averaged 54 million pounds annually during 1985-2001, typically represents from about 60% to 70% of this total. Trawls account for virtually all of the brown shrimp harvest in offshore waters (from 96% in 1998 to over 99% in many of the years during the mid-to-late 1980s).

Production of brown shrimp from inshore waters averaged 29 million pounds annually during the period of analysis (Table 3.3.5). In general, there has been a clear reduction in the take of inshore brown shrimp by the use of trawls. During the 1985 -89 period, the proportion of inshore brown shrimp taken by trawling activities exceeded 90%. During the 1990s, this proportion fell to 80%. During the most recent two years of analysis (i.e., 2000 and 2001), the proportion represented only about 55%. Butterfly nets (presumably including skimmers) represent the primary "other" gear used in the inshore brown shrimp fishery. Overall, harvest of inshore brown shrimp with the use of trawls averaged 21.2 million pounds annually since 1990 while harvests with wing-nets averaged seven million pounds.

White shrimp landings fluctuated from about 35 million pounds to 70 million pounds during the

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[33] A cautionary is warranted regarding 'catch by gear' in the last two years of analysis. Specifically, Louisiana, the largest producer of shrimp in the Gulf in terms of poundage, initiated a trip ticket system in 1999 which became fully implemented by 2000. As such, some of the noted change in 'catch by gear' may be nothing more than an artifact of a change in data collection methods.

period of analysis and averaged 50 million pounds annually (Table 3.3.5). Harvest in offshore waters averaged 30 million pounds annually during the period of analysis while production from inshore waters averaged 20 million pounds. As was the case with brown shrimp, virtually all of the white shrimp harvested offshore is taken with trawls while a declining proportion of the inshore catch is derived from trawls. Specifically, about 90% of the inshore white shrimp harvest was taken by trawls during the mid-to-late 1980s. By the late 1990s, this share had fallen to less than 70%. During the last two year period of analysis, less than 50% of Gulf inshore white shrimp harvest was taken by trawls.

3.3.1.4.1.3 Production by area

In terms of landings, Louisiana has historically contributed about 45% of the Gulf production (pounds) while Texas has contributed an additional 35%. Because of the larger shrimp landed in Texas, however, the dockside value of Texas shrimp landings tends to exceed that of Louisiana. The remaining production is relatively evenly distributed between Florida, Alabama, and Mississippi.

In addition to the landings statistics by state, NOAA Fisheries maintains detailed records on catch by statistical grid. These grids range from 1 (i.e., the Florida Keys) to 21 (Brownsville Texas area). While the grid system is not completely compatible to state boundaries, it does allow for a much more detailed analysis of catch by area.

Grids 18 through 21 roughly defines the Texas boundaries. Average annual shrimp catch from these four grids equaled 42 million pounds annually during the 1985-2001 period (Table 3.3.6). Approximately three-quarters of this total was harvested in offshore waters. The two northern most Texas grids (i.e., 18 and 19) have historically accounted for about 70% of the Texas shrimp catch.

Grids 11 through 17 roughly traverse Louisiana's boundaries.[34] Reported catch from these grids averaged 85 million pounds annually during the 1985-2001 period (Table 3.3.6). This represents about 60% of the total reported Gulf shrimp catch during the period. As previously noted, shrimp landings in Louisiana have historically represented only about 45% of the region's total. The difference between the catch statistics and landings statistics reflects, in large part, catch of shrimp in Louisiana's waters that is landed in ports outside the state. While apparently 60% of the shrimp harvested in Louisiana's waters are caught offshore, there appears to be a clear increase in proportion caught offshore as one moves westerly (i.e., from grid12 to grid 17).

Florida is roughly covered by grids 1 through 9. Catch in these grids has averaged about 12 million pounds annually during the period of analysis, or about eight percent of the total reported Gulf of Mexico shrimp catch. No inshore catch is reported in grids 1 through 4, likely reflecting the prohibition of shrimping in the Tortugas.

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[34]To some unknown extent, grid 11 may also capture some shrimp catch from Mississippi waters.

3.3.1.4.2 Value and price

The deflated value and price (1982-84 period used as the base) of the Gulf shrimp landings is provided in Table 3.3.7. While highly variable on a yearly basis, the deflated value has been trending downward. Overall, the average annual deflated value of $295 million during 1997-2001 represents a decline of about 25% when compared to the 1985-89 average annual deflated value of $389 million. Since pounds landed during this later period was less than five percent below that reported during the earlier period, a reduction in the deflated price is evidently responsible for most of the decline in value. The deflated price has been gradually trending downwards (Table 3.3.7).[35]

Though typically accounting for only about two-thirds of poundage, the value of offshore production accounts for more than three-quarters of the total dockside value of the Gulf of Mexico shrimp fishery (Table 3.3.7). This reflects the larger size harvested in offshore waters and the commensurate higher per pound price.

The long-term downward trend in the deflated dockside price of Gulf shrimp reflects, primarily, increasing imports of shrimp that have been increasing competing with the domestic product in the market place. Overall, imports of shrimp advanced from about 450 million pounds (heads-off weight basis) in 1985 to more than a billion pounds in 2001. This increase, by and large, reflects increased aquaculture activities throughout the world, but primarily in Asia and South America. Keithly and Roberts (2000), Keithly and Diagne (1998), and Vondruska (2001) provide descriptions of the world shrimp situation and the impact of increasing world production and resultant imports on the Gulf dockside shrimp price.

While there has been a gradual decline in Gulf of Mexico dockside shrimp price since the 1980s, the decline has been particularly abrupt since mid-2001. To a large extent, this abrupt decline reflects a contraction of the world economy vis-à-vis that of the U.S., the absolute softening of the U.S. economy, and action taken in the European Union regarding the prohibition of the importation of shrimp with carcanogenic chemical residue. This last factor was primarily of a short-term nature but did result in increased exports of the Asian product to the U.S., causing a further deterioration in dockside price.

3.3.1.4.3 Effort and Industry Characteristics

The Gulf shrimp fishery has changed considerably over the past several decades. Since the 1980s, much of the change has been the result of the long-term downward trend in the deflated price received by the fishermen.

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[35] As noted by Vondruska (2001), the more or less downward trend in price has been occurring since the late 1970s.

Estimates of number of vessels in the Gulf of Mexico shrimp fishery are of a notoriously dubious nature.[36] Vondruska (2001) suggests that all estimation procedures point to a significant expansion in fleet size from the mid-1960s through the late 1980s. By the late 1990s, however, the number of vessels appears to have fallen sharply; perhaps by a fifth to a third (Vondruska, 2001). Vondruska also reports that the average age of the Gulf shrimp fleet has also increased steadily since the late 1970s. The aging of the fleet in conjunction with the decline in fleet size undoubtedly reflects, in part, a reduction in profitability from shrimping activities in conjunction with the decline in the deflated price received for the product.

The number of vessels is not an "ideal" measure of effort in the Gulf of Mexico shrimp fishery. NOAA Fisheries prefers to use 24-hour fishing days as a measure of effort. Specified as such, total number of days fished in a given year and area is equal to the average length of a trip in a given area (cell, or NMFS Statistical Grid with depth zones, Figure 2.1.3) in the specified year multiplied by the yearly number of trips in that area (cell). Summation across cells provides an estimate of total effort, expressed in 24-hour days fished.[37]

Shrimp effort is not measured directly, haul-by-haul, but is estimated from landings and interview data gathered by port agents from fishermen at the end of fishing trips. The total pounds landed from each trip are assigned to one or more of the depth-area cells, based on the fisherman's recall. Accuracy of the total effort is directly proportional to the accuracy of the landings distribution and the CPUE estimates. Preliminary studies of a type of electronic logbook indicate substantial differences between the effort estimates from port samplers and the effort estimations from the electronic logbook (Gallaway *et al*. 2003 a, b). Bias in the location of the catch and underestimates of CPUE result from port samplers, if the electronic logbook accurately portrays fishing patterns. The use of an electonic logbook may generate more accurate information regarding spatial and temporal aspects of shrimp fishing effort. Research into the efficacy of electronic logbooks could determine if this new technique improves catch location and effort estimation (Section 4.4.2.7).

The number of shrimp trips, according to Vondruska (2001) fell from 406,000 in 1987 to about 200,000 in 1999 before expanding to about 215,000 in 2001 (M. Travis, per. Comm). Because of an increasing average length of trip, however, days fished did not decline in proportion to trips. There was, however, almost a 30% decline in days fished between 1987 and 1999, from 372,000 to 268,000.

While data are not available for 2002, anecdotal information would suggest that trips and days fished for this year would be exceedingly low, relative to the historical base. This reduction reflects both an abrupt decline in the dockside price as well as higher fuel costs. Whether this reduction continues into the foreseeable future will depend, to a large extent, upon changes in

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[36]See Table 1 in Amendment 11 to the *SFMP* for two differing estimates of the historical number of vessels in the fishery.

[37]Many concerns have arisen over the effort data set. Included in these concerns is that interviews may not accurately reflect the proportion of landings and effort by craft type, that catch per unit effort may go unreported at certain times and areas due to lack of interviews with shrimpers (Nance, 1992) and that several characteristics of fishing power may have varied over time

dockside price. This, in turn, is likely to be dependent upon U.S. and world economic activity as well as additional advances in shrimp farming activities. All of these issues are unknown at this stage.

A map depicting commercial shrimp trawl fishing effort in the Gulf is shown in Figure 3.3.8. The greatest amount of effort occurs in the area of the Mississippi Delta and westward.

3.3.1.5 Stone Crab

Like spiny lobster, commercial stone crab (*Menippe mercenaria)* fishery is primarily limited to the coastal waters of the state of Florida. *The Fishery Management Plan for the Stone Crab Fishery of the Gulf of Mexico (SCFMP),* originally developed in response to competing gear use between stone crab and shrimp fishermen, was implemented in 1979.[38] The Objectives, as outlined in the original SCFMP, included: (1) provide for orderly conduct of the stone crab fishery in the management area in order to reduce conflict between stone crab fishermen and other fishermen in the area, (2) establish an effective statistical reporting system for monitoring the stone crab fishery, (3) attain full utilization of the stone crab resource in the management area[39], and (4) promote uniformity of regulations throughout the management area.

The last objective is of particular relevance in this fishery because, traditionally, the vast majority of stone crab harvest has been taken from state waters (out to nine nautical miles on the Florida west coast). Primary regulations for this fishery in the state of Florida are summarized by Muller and Bert (1997). Some of the more relevant regulations are as follows: (1) only the claws can be removed and minimum size for claws is 2-3/4 inches in length; (2) the open season for the stone crab fishery is from October 15 through May 15; and (3) specifications regarding trap design and when the traps can be deployed. More recently, as discussed in detail below, a stone crab trap limitation has been implemented.

Since its implementation, the *SCFMP* has been amended seven times; the most recent amendment being submitted to the Secretary of Commerce in 2001. Of particular relevance, Amendment 5 provided the Regional Administrator of NOAA Fisheries the authority to place a three-year moratorium (April 15, 1995 to June 30, 1998) on the registration of stone crab vessels.[40] This initial moratorium has been extended through June 30, 2002 via implementation of Amendment 6.

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[38]As indicated in the *SCFMP*, management measures related to the plan are confined to Gulf of Mexico Fishery Conservation Zone adjoining the West Coast of Florida from the Florida-Alabama line southward to and including the Keys.

[39]Subsequently, this objective was deleted in Amendment 7 and replaced with the following objective "Take regulatory action to increase catch per unit effort (CPUE) and reduce overcapitalization in terms of gear deployed in the fishery." The rationale for this change is provided in this section.

[40]The purpose of this moratorium, as noted in Amendment 7, was "...because the Florida Legislature proposed a state moratorium on issuance of permits while the industry considered development of a effort reduction or limited entry program (p. 3)."

As noted in Amendment 7, the Stone Crab Advisory Panel had requested that the Council take action to limit participation in the fishery as far back as the mid-1980s. Serious discussions of alternative programs began in 1996 when the industry, through its associations, and in coordination with the state and (to a lesser extent) the Council, agreed upon a trap reduction program. This program, would result in a reduction of traps over time which would, in theory, result in increased CPUE and a reduction in overcapitalization.

Associated with the development of a trap reduction program, the Florida Marine Fishery Commission, in 1996, identified nine problems in the stone crab industry (Amendment 7, p. 22). These included: (1) Excessive growth in the trap fishery has reduced efficiency in the industry and not producing any new yield; (2) Excessive growth has increased conflicts with the shrimp trawl fishery, (3) Buoy ropes damage live bottom such as soft corals, and traps set in manatee grass damage the grass by shading and crushing. Excessive growth in the industry accentuates this problem; (4) Shoreline debris resulting from lost ropes and buoys increase with increasing numbers of traps. Catastrophic losses during hurricanes increase this problem; (5) There is an excessive demand for bait. {note: In recent years, the industry has shifted to using primarily pigs' feet rather than fish; therefore, the excessive demand for finfish no longer exists}; (7) Crabs become smaller and smaller with increasing overcapitalization, leading to a loss in value; (8) Excessive growth has led to conflicts and practices not in the best interest of the fishery {e.g., harvest/sale of light claws, careless breaking of claws}; and (9) Law enforcement problems grow as profits dissipate and some crabbers become more economically desperate. The Florida Fish and Wildlife Conservation Commission, subsequently, identified an additional problem, (10) Turtles, manatees, and dolphins may, on occasion, become entangled in buoy traps.

Similar to the spiny lobster trap reduction program, a stone crab trap reduction program was approved by the Florida Fish and Wildlife Conservation Commission in February, 2000. The principle goal of the program, as identified in Florida Statute 68B-13010(1), is to "... stabilize the fishery while generating an optimum sustainable yield utilizing the fewest number of traps."

As described in Amendment 7, "[t]he (State of Florida) trap management program is a certificate based attrition program which attempts to grandfather fishermen into the program with the present level of traps and then slowly reduces trap numbers to the optimum level by reducing the number of certificates whenever they are sold (p. 23)." The Gulf of Mexico Management Council plan (i.e., for fishing stone crabs in the EEZ, beyond nine nautical miles in the Gulf) has a number of salient features that, while in some ways attempts to be compatible to the state program, also differentiates it from the state program. A summary of the program, provided on page 24 of Amendment 7, includes the following features: (1) While the GMFMC program recognizes the state license and tags for use in the EEZ, it does not require them; (2) Persons who could not obtain, or chose not to obtain, the state license can apply for a Federal permit; (3) The same qualifying criteria would apply for acquiring a Federal permit as those required for qualifying under the state program {i.e., 300 pounds of claws landed in one of the fishing seasons 1995/96 through 1997/98}; (4) Persons qualifying would be issued a trap certificate and Federal trap tags based on their landings divided by five pounds which is the annual harvest level that would occur when the number of traps is reduced to the optimum of 600,000 traps[41]; and (5) Federal vessel permits, trap certificates, and tags would be non-transferable to other persons.

Like the State program, the primary goal of GMFMC stone crab trap reduction program is to "...increase catch per unit effort (CPUE) and reduce overcapitalization in terms of gear deployed in the fishery (Amendment 7, p. 17)." As stated in Amendment 7, "[t]he proposed Federal trap limitation program tracks the state program in most respects by recognizing, though not requiring, the state trap certificate program and providing for similar eligibility requirements as the state program. The major difference between the two programs is that the Federal permit and traps apply only to fishing in the EEZ and are not transferable while those for the state program apply to fishing in both state and Federal waters and are transferable (p. 37)."

In essence, both the state and Federal programs represent attempts of rationalizing effort in the fishery; hence, achieving the stated goal of increasing CPUE and reducing overcapitalization in terms of gear deployed in the fishery. The following description of the fishery attempts to illustrate changes in the fishery that have prompted such actions.

3.3.1.5.1 Poundage

Gulf of Mexico landings of stone crabs (whole weight) for the 1985-2001 period are presented in Table 3.3.3. While increasing from the mid-1980s until the early 1990s, landings, as indicated, have been stable since this later period. Since 1990, landings have ranged from 5.4 million pounds to 7.0 million pounds and have averaged 6.4 million pounds annually.[42] As noted in Amendment 7, MSY for the fishery is probably 3.0 million to 3.5 million pounds of claws (6.0 million to 7.0 million pounds whole weight), suggesting that the fishery is fully utilized in terms of annual production that could be derived on a sustainable basis.

In excess of 95% of Gulf of Mexico stone crab landings occur in Florida with landings from Alabama through Texas accounting for only about 125,000 pounds annually. Furthermore, Muller and Bert (1997) report that Florida landings tend to be heavily concentrated in the Southwest region of the state, i.e., the area extending from Charlotte County to Monroe County. Specifically, the authors suggest that this area accounted for about 70% of the state's stone crab landings during the 1985/86 through 1995/96 period. The Central region, extending from Citrus County to Pasco County, accounted for an additional 16% while the Tampa Bay Region (i.e., Pinellas County through Sarasota County) contributed about five percent to the total. Finally, landings in the Big Bend Region (i.e., Franklin County through Levy County) contributed about six percent of the total. As noted in Amendment 7, there has been a gradual geographic expansion of effort and catch northward to the Florida Big Bend area.

[41] Specifically, the "five pounds was selected because it would be the average annual landing per trap for the fishery when the number of trips (sic) is reduced to the optimum level of 600,000 (Amendment 7, p. 28.)"

[42] Though not shown in Table 2.1, it is worth noting that Gulf of Mexico stone crab landings increased consistently from the early-to-mid 1960's, during which period landings equaled less than one-million pounds annually, up until the late 1980's, at which point landings were averaging approximately five million pounds annually.

In addition to the northward expansion of effort and catch, the fishery has also expanded seaward further offshore. During 1993/94 for example, only 82 Florida-based trips reported the harvest of stone crabs from the EEZ with total landings from Federal waters of 6,829 pounds (claw weight). By the 1997/98 season, trips in the EEZ had increased to 6,700 while catch increased to 1.3 million pounds (claw weight). Trips in Federal waters in 1998/99 equaled 6,354, or 30% of all reported stone crab trips on the west coast of Florida while landings from Federal waters equaled 975,000 pounds (claw weight), representing more than 40% of Florida west coast landings.

The stone crab fishery is primarily a trap-based fishery. More than 95% of the total Gulf of Mexico stone crab landings are taken by traps though less than 90% of the 2000 and 2001 landings are reportedly taken from traps.[43] As was the case with spiny lobster, the stone crab trap limitation program instituted by the state of Florida likely resulted in increased stone crab take from diving.

Finally, Vondruska (1998) reports a compression of the "effective" stone crab season. During the 1977/81 period, for example, an average of 41% of the Florida west coast stone crab harvest was reported during the October through December period while an almost identical percentage was reported during the February through April period. By the 1993-97 period, the October through December share had increased to 57% while the February through April share had fallen to less than 30%.

3.3.1.5.2 Value and Price

The value and price for the Gulf of Mexico stone crab commercial fishery is presented in Table 3.3.3. As indicated, the value of landings increased in association with increased poundage. Though illustrating considerable year-to-year variation, the deflated dockside price of the harvested product has also been gradually increasing during the period of analysis.[44] Dockside price analysis by Adams and Prochaska (1992) indicates that while the dockside price is relatively unresponsive to changes in quantity harvested, dockside price is relatively responsive to changes in income. The high rate of growth in U.S. income during the 1990s likely contributed to the increase in price.[45]

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[43]There is an apparent error in the 1991 catch by gear data. In this year, almost 35% of landings are reportedly taken from gear other than traps.

[44]Some of the variation in yearly dockside price may be the result of annual changes in proportion of claw landings by size. The crab claws are marketed based on size - ranging from "jumbo" to "small" - with a premium being received for the larger sizes. In 1997, for instance, "small" claws commanded a dockside price of $3.66 per pound compared to $7.57 per pound for the "jumbo" claws (Vondruska, 1998).

[45]It is noteworthy that dockside price fell sharply in 1991 and 2001. Both of these years were recessionary which would likely explain the price reductions.

3.3.1.5.3 Effort

Effort in the stone crab fishery is discussed in Muller and Bert (1997), Vondruska (1998), and Amendment 7 to the *SCFMP*. As such, only a brief summary of some of the relevant findings is presented here.

As indicated by Muller and Bert (1997), traps deployed in the fishery advanced from 421,000 in 1984/85 to almost 800,000 in 1995/96. During the three year period after 1995/96 (i.e., through 1998/99), the number of traps deployed increased by about 60% to an estimated 1.3 million (Amendment 7). Given the relative stability in pounds landed during the 1990s, the increasing number of traps has resulted in a continuing decline in production per trap.[46]

In conjunction with the increased number of traps in the fishery, the number of commercial trips increased during the 1985/86 through 1995/96 period (Muller and Bert, 1997). In the "prime" stone crab producing region, i.e., Charlotte County to Monroe County, trips during this period increased form 14,000 to almost 25,000. Similarly, the number of vessels (five net tons or greater) in the Florida west coast stone crab fishery increased from about 200 to about 350 during the same time period (Vondruska, 1998).[47]

In summary, as noted in Amendment 7, the stone crab fishery is grossly overcapitalized and the trap limitation program is "... designed to reduce the number of traps, reducing overcapitalization and making the industry more efficient (p. 25)." It is anticipated, however, that the optimum target level of 600,000 traps may not be achieved for many decades; possibly in excess of 30 years.

A map depicting commercial stone crab trap effort in the Gulf is shown in Figure 3.3.9. The greatest amount of effort occurs along the West Florida coast, especially in the area of the Florida Keys and Ten Thousand Islands.

3.3.1.6 Spiny Lobster

The *Spiny Lobster Fishery Management Plan for the Gulf and South Atlantic (SLFMP)* was implemented in July 1982. The objectives associated with the *SLFMP*, when implemented, included the following: (1) to protect long-run yields and prevent depletion of the lobster stocks, (2) to increase yield by weight in the fishery, (3) reduce user group and gear conflicts in the fishery, (4) acquire the necessary information to manage the fishery, and (5) promote efficiency in the fishery. Amendment 2 to the *SLFMP* added a sixth objective; that being to (6) provide for a more flexible management system that minimizes regulatory delay to assure more effective,

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[46]When evaluated over a longer time frame, the catch per trap has fallen from more than 20 pounds (claw weight) in the early 1960's to less than four pounds in 1995/96. Given the more recent "surge" in number of traps (i.e., to 1.3 million in 1999), catch per trap may currently be less than 2.5 pounds (claw weight) annually.

[47]Caution should be exercised when using the Operating Unit File. Specifically, only vessels have been included in the annual survey since 1994.

cooperative State and Federal management of the fishery.

In general, much of the original rationale for the *SLFMP* was to extend Florida's rules regulating the fishery to the EEZ and throughout the range of the fishery; i.e., North Carolina to Texas (though as discussed later, almost all of the fishery is concentrated in South Florida). Within territorial waters (nine nautical miles on the west coast of Florida), management of the spiny lobster fishery falls under the auspices of the Florida Marine Fisheries Commission. The State of Florida, under an agreement with the Gulf and South Atlantic Fishery Management Councils, also has responsibilities for management of the spiny lobster fishery in the Exclusive Economic Zone which extends to 200 miles (Milon *et al*., 1999).

As noted by Milon *et al*. (1999), most management regulations are "designed to protect the reproductive capabilities of the stock (p. 1)." Other regulations governing commercial harvesting practices include the construction of traps (e.g. size and materials). The first significant attempt to limit the total amount of effort in the fishery was taken in 1988 when a 3-year moratorium on the issuance of new traps was imposed. Subsequently, beginning in 1992, a trap reduction program was implemented.[48] From 1993/94 through 2001/2002, the number of active (refers to tag issuance, not whether the trap was actively used) spiny lobster trap tags was decreased from just over 700,000 to about 545,000.

3.3.1.6.1 Poundage

Spiny lobsters (*Panulirus argus)* are primarily harvest along the southern coast of Florida. Pounds landed in the Gulf, with few exceptions, generally fall in the 4.5 million to 6.5 million pound range (Table 3.3.1). Reported landings of less than 3.0 million pounds in 2001 are by far the lowest dating back to 1985 and equal only about one-half of the average annual landings (5.6 million) during the period of study.[49]

Lobster pots represent the predominant gear used in the harvest of spiny lobster. From 1985 through 1999, lobster pots consistently account for more than 90% of spiny lobster harvest and in many years represented in excess of 95% of the total (Table 3.3.2). A decline in the percentage of harvest by lobster pots, however, is evident in recent years. This decline reflects the fact that diving activities have been taking an increasing share of the total landings. Prior to 1997, harvest from diving activities rarely accounted for more than 200,000 pounds of spiny lobster. Since 1997, harvest from diving has averaged in excess of 300,000 pounds annually with a peak of close to 450,000 pounds in 1999. The reason for the increased harvest from diving activities is

[48]This program is discussed in greater detail in a subsequent section. In addition to this program, classification of spiny lobster as a "restrictive species" became effective in 1994. This designation requires a special endorsement, based on minimum fishing income criteria.

[49]The primary fishing area for spiny lobster, is as noted, the Florida Keys. Given the physical characteristic of this area, some discussion of the landings data is warranted. Specifically, all product landed in Monroe County, the primary landings port, is considered to be landed in the Gulf even though Monroe County traverses both the Gulf and South Atlantic Coasts. When examined by area caught, less than 3.0 million pounds of lobster are generally reported harvested from Gulf waters.

hypothesized to be related to the transferable trap certificate program that was instituted in the fishery in 1992.[50]

The only other gear of commercial relevance in the harvest of lobster is shrimp trawls (averaging almost 50,000 pounds per year during the study period). In this case, the take of lobsters is bycatch in the targeting of shrimp. Anecdotal information suggests that spiny lobsters are particularly susceptible to shrimp trawl harvest while migrating during cold fronts.

3.3.1.6.2 Value and Price

The value of Gulf landed spiny lobsters advanced from an average of approximately $15 million annually during the mid-1980s to more than $25 million annually by the late 1990s before falling sharply in 2001 in conjunction with the decline in production (3.3.1). After adjusting for inflation (1982-84 Consumer Price Index used for the purpose of deflating value and price), growth in the value of dockside landings was considerably more moderate. During the 1985-89 period, for instance, the deflated value of Gulf of Mexico commercial spiny lobster landings averaged $14.1 million annually, or about 10% less than the average of $15.8 million during 1996-2000 (due to the abnormally low production reported in 2001, this year was not used in the calculation).

The relatively constant deflated value of the landed product in conjunction with the relative stability in production indicates that the deflated per pound price must also be relatively constant. Examination of the information contained in Table 3.3.1 suggests this to be the case. Overall, the average annual deflated dockside price of $2.53 per pound during 1996-2000 was only marginally higher than the $2.47 per pound price derived for the 1985-89 period.

3.3.1.6.3 Effort

The commercial spiny lobster fishery, as noted by Milon *et al*. (1999), has been dominated by the use of traps since the early 1960s. As reported by the authors, the number of traps employed in the fishery expanded from about 100,000 in the early 1960s to more than 900,000 in 1990. Despite the increase in number of traps, total landings have exhibited no long-term patterns.

As noted by Milon *et al*. (1999), "[e]ven though the significant increase in trap numbers did not appear to have a corresponding effect on landings (that would provide for obvious concern for the health of the stock), it did raise several other concerns that were cited by the Florida Legislature." Specifically, as stated in Florida Statute 370.142(1):

> Due to rapid growth, the spiny lobster fishery is experiencing increased congestion and conflict on the water, excessive mortality of undersized lobsters, a declining yield per trap, and public concern over petroleum and debris pollution from existing traps."

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[50]This program is discussed in greater detail in a subsequent section.

To address these concerns, the Florida Legislature, in 1992, implemented a Trap Certificate Program (TCP), the goal of which was "...to stabilize the fishery by reducing the total number of traps, which should increase the yield per trap and therefore maintain or increase the overall catch levels (Florida Statute 370. 142(1) as quoted by Milon *et al*. (1998)).

As discussed by Milon *et al*. (1998), qualified commercial fishermen were issued a specific number of certificates under the TCP with the allocation of the certificates based on reported landings in previous seasons.[51] Each certificate allows the use of one trap. Certificate owners, upon payment of appropriate fees, are permitted to sell all or a portion of their certificate holdings to other fishermen. Based on the goals of the TCP, the total number of certificates and, hence, the number owned by each individual can be periodically reduced.

When instituted in 1992, a total of 727,000 trap tags were issued by the Florida Fish and Wildlife Conservation.[52] Via the reduction program, this number was reduced to 544,000 in 1998/99 and remained at that level through 2001/2002. Furthermore, after implementation of the TCP, the number of firms (vessels) and traps per vessel have both declined (Milon *et al*., 1998). Overall, the number of fishermen holding trap certificates fell from 3,766 in 1992/93 to 2,235 in 2001; or by about 40% (unpublished data provided by the Florida Fish and Wildlife Commission). The size of the average operation between 1993 and 1999, however, increased from approximately 196 to 252 certificates while the maximum number of certificates held by any individual increased from 3,674 to 5,631 (Milon *et al*., 1998).

Despite the reduction in traps, spiny lobster landings have, as noted, remained relatively stable (Table 3.3.1). Overall, during the TCP, catch per trap has advanced from less then seven pounds to more then 12 pounds (Milon *et al*., 1998). This would suggest total revenues of approximately $60 per trap, based on the 2000 dockside price of $4.89 per pound.

Despite the significant reduction in trap usage in the Gulf of Mexico spiny lobster fishery, research by Milon *et al*. (1999) suggests that further reduction in trap usage is warranted if maximizing economic efficiency is a primary goal of the TCP. Specifically, the authors found that the number of traps that would maximize short-term (i.e., single year) profits per trap fell in the 160,000 to 260,000 range with the optimal number increasing by about 10% when future years are considered.

A map depicting commercial lobster trap fishing effort is shown in Figure 3.3.10. Most of the effort occurs in the area of the Florida Keys and Ten Thousand Islands.

3.3.1.7 Coral and coral reefs

The *Fishery Management Plan for Corals and Coral Reefs (CCRFMP)* was submitted for

[51] See Milon *et al*. (1998) for a detailed description of eligibility and initial certificate allocation.

[52] As cited by Milon *et al*. (1998), based on studies by Muller *et al*. (1997) and Harper (1995), the number of traps in the fishery approximated 940 thousand.

Secretarial approval in April 1982 and was implemented in 1984. The impetus for the development and implementation of the *CCRFMP* was the result of the following concerns: (1) the need to provide immediate protection to what is, for the most part, an unprotected and important nonrenewable resource, (2) the need to acquire additional information on the resource, and (3) the need to prevent any sudden devastation to the resource that could be brought about by: (a) sudden intensive harvesting and (b) sudden intensive destruction of the resource by man, e.g., a quantum jump in the use of roller rig trawls or bottom longlines.

To address these concerns, the following objectives were specified: (1) develop scientific information necessary to determine feasibility and advisability of harvest of coral; (2) to minimize, as appropriate, adverse human impacts on coral or coral reefs; (3) to provide, where appropriate, special management for coral habitat areas of particular concern ; (4) to increase public awareness of the importance and sensitivity of coral and coral reefs; and (5) to provide for a coordinated management regime for the conservation of coral and coral reefs.

In general, the *CCRFMP* set optimum yield for stony corals and sea fans at zero, except as may be authorized by the Southeast Regional Director (Administrator). Optimum yield for octocorals, except for sea fans, was set at the level harvested by U.S. fishermen with the expected level of harvest estimated to be 1,463 colonies annually from the EEZ (based at the time that the FMP was being drafted). This harvest was conducted by the marine life industry in South Florida who also harvested an estimated additional 4,400 from state waters.

The *CCRFMP* required that persons utilizing chemicals to collect fish in coral reef area must first obtain a permit from the Regional Administrator or the State of Florida where most collecting occurs. Persons who propose collecting prohibited corals from the habitat areas of particular concern established under the *CCRFMP* must also obtain a scientific permit from the Regional Administrator. Regulations promulgated through the *CCRFMP* prohibited non-permitted persons from damaging, harming, killing, or collecting prohibited coral which includes all stony coral, sea fans, and coral reefs and coral in habitat areas of particular concern.

The CCRFMP has been amended three times since its original implementation. The most relevant of these is Amendment 3. It established an annual quota of 500,000 pounds for the take of wild live rock from open areas in the Gulf EEZ in 1995 and 1996 after which all harvest would end. This amount would be equal to OY during the phase-out after which optimum yield would equal zero.

While there is currently no direct take of coral or live rock from the Gulf of Mexico EEZ (except under rare scientific purposes), this does not imply that no benefits are derived from this habitat. It is of importance to a wide range of non-consumptive users (e.g., divers) and provides habitat or related ecosystem services needed for commercial and recreational fishing activities.

3.3.2 Fishing Communities

3.3.2.1 Introduction

This description of the human environment includes a compilation of various social indicators that are relevant to fishing, fishermen and fishing communities. These indicators provide baseline information from which assumptions about social impacts can be made regarding actions concerning essential fish habitat.

The communities included within this document are those that may have substantial fishing activity associated with a certain bounded area for each of the five Gulf States and are recognized by the census as incorporated communities or Census designated places. They do not represent a definitive list of fishing communities within the Gulf of Mexico Fishery Management Council's jurisdiction. By combining secondary data, such as Federal permits and other types of information from different levels and concepts of place (zip code, homeport and Census Designated Place; as discussed in Section 2.1.6.2.2.2) a list of those communities that may be impacted by council regulations was assembled. While at this time there are no standard guidelines for delineating the boundaries of a fishing community it is unrealistic to refer to these communities as "fishing communities" in strict terms as outlined in the M-S Act[53]. We can only assume that these communities may be impacted by council action because they have some or substantial fishing activity taking place within each community.

Without extensive ethnographic research into social networks and sense of place, it is impractical to assume that we know the exact boundary around a fishing community and can identify fishing communities within the Gulf of Mexico Fishery Management Council's jurisdiction. Therefore, the communities listed below and in Appendix D represent a partial and/or incomplete list of communities that could be potential fishing communities. In addition, the criteria that were used to determine vulnerability may not be sufficient in determining all the impacts of regulation and other criteria may need to be considered.

However, because there has been no methodological attempt to identify fishing communities for the GMFMC to date, the communities listed here will have to represent those communities which have the potential for being impacted by the regulatory process of fisheries management. While it is much more desirable to have verification on the ground, this exercise was conducted using secondary data entirely and most often collected for other purposes. Therefore, the communities listed here may be incomplete or imprecise, yet is the best attempt to identify "fishing communities" to date.

Through an examination of Federal permits and zip code business patterns data, communities with considerable fishing activity have been identified. Those communities with considerable fishing activity might be those that have either a high number of fishing permits, or a substantial number of permits of one type or in one sector, a large number of people employed in fishing

[53] In 16 U.S.C. 1802 § 3 definitions of the Magnuson-Stevens Act (104-297 (16)), *fishing community* means "a community which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community."

related businesses or a large number with fishing related employment compared to other employment. In addition, because important fisheries like the shrimp fishery have required permits only recently (2003), qualitative information from previous research has also been used to help identify those communities with substantial shrimp fishing activity.

This description focuses on describing the fishery through profiling vessels and fishing communities of the Gulf of Mexico. The description of communities is comprised of demographic data from the U.S. Census Bureau that includes statistics on population, education, poverty and occupation. Data from the zip code business patterns is also incorporated for all zip codes associated with census-designated place. Zip code business pattern data are more detailed than occupation data from the census. Employment figures for specific North American Industry Classification System codes that are associated with seafood harvesting, processing and distribution are used as an indication of employment in the commercial fishing sector. Employment figures on marinas are used for an indication of employment associated with the recreational fishery. Although there are many support industries associated with recreational fishing, these industries are often embedded within larger census categories for industrial classification and cannot be extracted without a finer level of detailed coding. The same is true for support industries for the commercial fishery. In addition, some data are suppressed at the Zip code level due to confidentiality concerns and are not accessible, i.e., earnings data.

With the year 2000 census, substantial changes were made in data collection method and in data reporting. For the category of race, census respondents were offered for the first time the choice of more than one category of race. Therefore, numbers for any particular race in 2000 that are reported are usually only those categories in which an individual reported one race only and therefore may be underreporting any particular race. Furthermore, for the categories of industry and occupation this census used the new NAIC classification codes for the first time. Because many older SIC codes no longer exist, comparing industry and occupation over several decades is problematic. An attempt was made to re-categorize industry classifications to match those of previous years using detailed tables of industry classification. In some cases, industry classification was substantially changed so numbers compared to the year 2000 for some classifications will be skewed. As for occupation, the changes were such that re-categorizing was not possible. The only occupational category that is reported for the year 2000 is Agriculture, Forestry, Fishing and Mining. Because so many of the occupational categories changed with the switch to NAIC classification, it was impossible to re-categorize and therefore since agriculture, forestry, fishing and mining did not change and it is the one category that most closely approximates employment in fishing it was reported for the year 2000.

The number of permitted vessels identified within each community as homeport and Zip code area are included in Appendix G. In addition, gear types used by vessels are also reported. The number of vessels are assigned to each community as designated through homeport permit data and Zip code.

Finally, with these data a vulnerability index has been devised which weighs various employment opportunities in the context of the demographic character for each community. The vulnerability index combines various quality of life variables into an index of vulnerability to compare the community and the county in which it resides. This comparison provides a more regional method to assessment of quality of life that goes beyond the community to factor in the migration patterns involved in work and meeting of basic needs.

3.3.2.2 Description of the Fishery

In the year 2000, twenty-seven Gulf of Mexico ports were listed among the top 91of ports ranked by dollar amount of commercial fishery landings. The highest ranking was Dulac-Chauvin, Louisiana with $68.1 million, while Houston, Texas was ranked 83rd with $4.5 million (NMFS, 2000). Overall, the Gulf of Mexico had landings valued over $910 million.

Landings for the Gulf of Mexico and States for the Year 2000 (NMFS 2000)

Region or State	Thousand Pounds	Thousand Dollars
Gulf of Mexico	1,759,993	910,645
Florida, West Coast	79,415	155,200
Alabama	29,931	63,275
Mississippi	217,744	58715
Louisiana	1,344,913	401,095
Texas	87,990	232,400

3.3.2.3 Commercial Fishery

The shrimp fishery is by far the most valuable in the Gulf of Mexico; in fact, it is the most valuable in the United States. The Gulf led the nation with shrimp landings of 256.6 million pounds that accounted for 77 percent of the national total in 2000. Louisiana had the most landings with 133 million pounds, followed by Texas, Alabama, Mississippi and Florida (West Coast) respectively. Shrimp vessels commonly use bottom-tending gear called an otter trawl, pulling from one to four nets per vessel. The shrimp permit system is in its initial stages and estimates of shrimp vessels in the Gulf may not be completely accurate as all shrimp vessels may not have completed the application process.

At present there are 3380 Federally permitted vessels in the Gulf of Mexico. The total number of permits in the following table adds to more than that, because many vessels hold more than one type of permit. Each permitted vessel may have several permits that allows the captain to fish a particular species or group of species for which the permit was established. Current permitted fisheries are: shrimp; king and Spanish mackerel; reef fish and red snapper; shark; spiny lobster; and swordfish. There are also permits required for charter vessels in the reef fish and coastal pelagic fishery.

Federal Permit Type 2002 (NMFS)

Type of Permit	Number
Shrimp	1532
Commercial King Mackerel	1657
Commercial Spanish Mackerel	1470
Reef Fish	883
Red Snapper License Class 1	127
Red Snapper License Class 2	342

Commercial Spiny Lobster	509
Charter/Head boat for Coastal Pelagics	1132
Charter/Head boat for Reef Fish	1059
Swordfish	130
Shark	325

3.3.2.4 Dealers and Processors

According to the NOAA Fisheries permit data there are 142 Federally permitted dealers in the Gulf region. The majority of those (68) are located in Florida which includes the Florida Keys. As the table below shows, Louisiana is next with 31 and Texas follows with 24.

Dealer Permits 2002 (NMFS)

State	Number
Total permits	142
Florida (Gulf dealers)	68
Alabama	14
Mississippi	5
Louisiana	31
Texas	24

3.3.2.5 Recreational Fishery

The recreational fishery of the Gulf of Mexico includes private individuals, rental boats, charter vessels, head boats and party boats. The private recreational sector in the Gulf of Mexico is surveyed through the Marine Recreational Fisheries Statistics Survey (MRFSS) except for the state of Texas. Texas conducts its own surveys of recreational fishing through the Texas Department of Parks and Wildlife (TDPW). Details on how the MRFSS data are collected and data limitations are provided in Section 2.1.5.2.1. The data are used to calculate estimates of fishing effort (number of trips made) and overall catch, catch by species or aggregations of species (e.g. epinepheline groupers) and are stratified by state, fishing mode, 6-month or annual periods, and fishing area.

MRFSS and TDPW data were used to generate maps of recreational fishing effort discussed below. The charter and head boat industry must have Federal charter permits for both the reef fish and coastal pelagic fisheries. Outside research on the charter and head boat sector provides much of the descriptive data, whereas the MRFSS survey is generally used to describe the private angling sector. Much of the private recreational data presented for each state was collected from the NOAA Fisheries' Fisheries Statistics and Economic Division Website.

3.3.2.6 Private Anglers

There were over 20.4 million marine recreational fishing trips in the Gulf of Mexico for the year 2000 (excluding Texas). Most of those trips were made in Florida (72%) with Louisiana second

(18%) and both Alabama and Mississippi with 5%. There were over 2.6 million participants who caught a total of 149 million fish (NMFS 2000). The species that were most commonly sought on fishing trips were red snapper, white grunt, dolphin, black sea bass, spotted sea trout, and red drum. Most often, the catch came on trips where individuals fished primarily in inland waters (64%) or in the state territorial sea (27%).

More descriptions of private angler fishing appear under the description of each state's fishing communities in Appendix D, except for Texas which conducts its own survey of recreational fishermen. That data was not collected for this document.

3.3.2.7 Charter, Head boats and Party boats

Charter boats are generally defined as for-hire vessels with a fee charged on a small group basis. Head boats and party boats also operate on a for-hire basis but with a per-person base fee charged. Charter boats are usually smaller, carrying six or fewer passengers. Party boats are larger and will carry as many passengers as possible to maximize income. They usually operate on a schedule; require a minimum number of passengers in order to make a trip.

In their recent study of the Charter/Head boat sector for the Gulf States of Alabama, Mississippi, Louisiana, and Texas, Sutton et al. (1999) estimated there to be 430 charter vessel operators and 23 party boat operators in the four state area. Over the past ten years there has been an increase in size and capacity of both charter and party vessels. Since 1987 charter vessels have more than doubled in number from 210-430 and the number of passenger-trips have tripled from 95,000 to 318,716. The state with the largest increase in number of passenger-trips was Mississippi with a 300% increase. Alabama was next with an increase of 165%, since 1987. Party boats have decreased in number since 1987 from 26 to 23. However, the number of passenger-trips, as with charter vessels, has tripled from 37,148 to 117,990. This increase may be attributed to the increase in size of vessels.

Sutton et al. (1999) estimated the impact of the charter industry on local economies for the four states in their study in 1997 to be $42.5 million in direct output, $15.6 million in income and 996 jobs.

The charter industry has raised concerns over certain aspects of the above study, specifically certain costs for repair and targeting behavior. The Gulf SEP has also provided the Council with a critique of the methodology and assumptions made in the report. However, the purpose here is to describe prior research for comparison and discussion purposes only.

Holland et al. (1999) estimated there to be 615 charter and head boats on Florida's Gulf coast and approximately 230 in the Florida Keys. Major ports in Florida on the Peninsula Gulf - Naples and Ft. Myers (and Ft. Myers Beach); on Florida's Panhandle Gulf - Destin, Panama City (and Panama City Beach) and Pensacola; and in the Florida Keys - Key West, Marathon and Islamorada. In their sample, most charter boat operators in Florida (90%) operate full-time charter businesses and have been in business for an average of 16 years. The majority (95%) lives near their homeport and has lived in their home county for more than 10 years. Head boat operators also were full time had been in business on average 22 years. Like their charter boat counterparts they too lived near their home port and almost all had lived in their county for more than ten years.

3.3.2.8 Vulnerability of Fishing Communities

The following summary table provides the vulnerability index score for fishing communities identified in Appendix D through the methodology discussed in Section 2.1.6.2.2.2. A more detailed description of each community which includes number of permits by species type and gear along with employment figures and a detailed outline of each vulnerability component score. The table provides a summary of those communities discussed and their score on the vulnerability index. The index score may also be consolidated into three general vulnerability categories of:

Not vulnerable (Index scores from 3 to 5)
Somewhat vulnerable (Index scores from -1 to 2)
Very vulnerable (Index scores from -5 to -2)

Fishing Community Vulnerability Index Summary Table

State	Community	Vulnerability Index Score
Alabama	Bayou La Batre	-3
	Dauphin Island	3
	Gulf Shores	3
	Orange Beach	-1
Florida	Apalachicola	-1
	Big Pine Key	4
	Bokeelia	-
	Carrabelle	-1
	Cedar Key	3
	Clearwater	1
	Cortez	1
	Crystal River	5
	Destin	5
	East Point	3
	Everglades City	4
	Ft. Myers Beach	5
	Ft. Walton Beach	1
	Gulf Breeze	5
	Homosassa	5
	Horseshoe Beach	0
	Inglis	-1
	Islamorada	4
	Key Largo	4
	Key West	4
	Madeira Beach	2
	Marathon	1

State	Community	Vulnerability Index Score
	Marco Island	5
	Matlacha	-
	Naples	5
	New Port Richey	1
	Panama City	1
	Panama City Beach	3
	Pensacola	1
	Port St. Joseph	0
	St. Marks	-1
	St. Petersburg	-
	Tampa	-
	Tarpon Springs	4
	Yankeetown	3
Louisiana	Cameron	-5
	Chauvin	-2
	Cutoff	1
	Delcambre	-1
	Dulac	-3
	Empire	-4
	Golden Meadow	-3
	Grand Isle	-3
	Houma	-3
	Morgan City	-1
	Venice	-3
Mississippi	Biloxi	0
	Gautier	-3
	Gulfport	1
	Pascagoula	-5
Texas	Aransas Pass	-1
	Brownsville	-1
	Freeport	-3
	Galveston	1
	Palacios	1
	Port Aransas	3
	Port Arthur	1
	Port Isabel	1
	Port Lavaca	-1
	Rockport	4
	Seadrift	-5
	South Padre Island	3

As stated above, in Section 3.2.2.1, this list of communities does not represent a definitive list of fishing communities within the Gulf of Mexico Fishery Management Council's jurisdiction. A rigorous approach was taken to identify communities in each of the Gulf states that may be impacted by fisheries regulation. However, other communities may meet future guidelines that are not yet available to define fishing communities. For that reason the following communities are included as possible fishing communities that were excluded but may require some consideration as communities that could potentially be impacted by Council action, but were not included within this initial exercise. This list of communities may be commonly considered fishing communities but were not included in the document due to a variety of reasons. For instance, information for some communities may be included in neighboring communities. This list was generated by the State representatives to the Gulf Council and consists of the following communities:

Louisiana	Yoloskey Cocdrie Galliano Leeville Pointe ala Hache Buras Hope dale Intracoastal City Freshwater City Cyprenort Point Hackberry Lafitte Sulphur
Mississippi	Bay St. Louis Pass Christian Moss Point Long Beach Ocean Springs
Alabama	Coden Bayou la Batre

Additionally, the Council requested that Fairhope, Alabama be taken off the list of fishing communities. It originally was listed with a vulnerability rating of 3. It should be noted that the Fairhope Zip code boundary included not only the Fairhope CDP, but also that of Point Clear, and encompasses an area much larger than both CDPs combined (Figure D.4, Appendix D).

3.4 Administrative Environment

3.4.1 Federal laws and policies

3.4.1.1 National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires all Federal actions to be evaluated for potential environmental and human environment impacts, and for these impacts to be assessed and reported to the public. As it applies to the formulation of fishery management plans, the NEPA process should ensure that the potential environmental ramifications of actions determined necessary to manage a fishery are fully considered. Thus, proposed regulations that may set size or bag limits, limits on the number of permits or vessels, quotas, allowable gears, closed seasons or areas and any other measure is reviewed for its potential effect on the broader marine environment, in addition to its effect on the specific fishery being managed.

Councils initially conduct an Environmental Assessment (EA), which is a concise statement that determines whether the FMP (and subsequently any proposed amendment to the plan) will have a significant impact on the environment. If there is no potential significant impact, a "Finding of No Significant Impact," or FONSI, is issued.

If there is a determination that the action will result in a significant impact, then a full Environmental Impact Statement (EIS) is required. In this determination, the Council must consider the context and intensity of the action or activity, both short term and long term effects, impacts that may be beneficial or adverse, and effects on locality and society as a whole. Generally, the EIS is drafted concurrently with the FMP and it lays out the proposed action(s), alternatives to the proposed action(s), and the environmental consequences for each alternative. The Draft EIS is sent to the EPA for a 45-day review period, and subsequently its availability is announced in the Federal Register. The public is afforded an opportunity to comment on it, generally concurrently with the public comment period for the FMP itself. The EIS is submitted to the Secretary of Commerce along with the FMP for final approval.

3.4.1.2 Magnuson-Stevens Fishery Conservation and Management Act

3.4.1.2.1 The Federal fishery management process

The Magnuson-Stevens Fishery Conservation and Management Act (M-S Act) was originally passed by Congress in 1976. Section 302 of the Act (§ 302) created eight regional fishery management councils, including the Gulf Council, to develop Fishery Management Plans (FMPs) to regulate fisheries in an effort to prevent overfishing. Councils prepare FMPs for each fishery under its jurisdiction, and submit these plans to the Secretary of Commerce for final approval.

Membership on Councils includes the directors of state fishery organizations, the Regional Administrator of NOAA Fisheries, and knowledgeable citizens appointed by the Secretary of Commerce as voting members and representatives from the U.S. Fish and Wildlife Service, Coast Guard, regional Marine Fisheries Commissions, and Department of State as nonvoting members.

During the process of developing FMPs, the M-S Act directs the Councils to conduct public hearings to provide opportunities for input from the affected public. The M-S Act also establishes a Scientific and Statistical Committee to assist with statistical, biological, economic, social, and other scientific information, and Advisory Panels to provide information and to assist in development and review of management plans and plan amendments.

When a council approves a plan, it forwards the plan to NOAA Fisheries for review and approval. NOAA Fisheries, NOAA, and NOAA General Counsel (GC) assure that the plan or amendment meets various Federal requirements. Following this internal review, the plan or amendment continues on a two-part track. One part leads to approval of the management plan or plan amendment, and the other leads to a final rule that establishes regulations.

For the management plan or plan amendment, NOAA Fisheries publishes a Notice of Availability that starts a 60-day public comment period. Following the comment period, NOAA Fisheries and NOAA GC conduct a final evaluation, and usually the plan is approved, disapproved, or partially approved at the National level. In rare cases, the Regional Administrator (in the case of Gulf Council plans, the Southeast Regional Administrator) takes over this function.

To implement a plan or amendment, NOAA Fisheries develops a Proposed Rule (PR) that also goes through NOAA Fisheries, NOAA, NOAA GC, and public review. After internal review, NOAA Fisheries publishes the PR in the Federal Register to start a 45-day public comment period. The Regional Administrator responds to the public comments, and then completes a rulemaking package for the Final Rule (FR). The FR undergoes further Federal review and approval by NOAA Fisheries, and gets published in the Federal Register.

3.4.1.2.2 History of Management of the Gulf of Mexico Fishery Management Council

The Gulf Council is one of eight regional Fishery Management Councils that were established by the Fishery Conservation and Management Act in 1976 (now called the Magnuson-Stevens Fishery Conservation and Management Act, as amended). The Gulf Council prepares fishery plans to manage fishery resources in the Exclusive Economic Zone (EEZ), the area from state waters out to the 200-nm limit). Development of the original fishery management plans (FMPs) and each subsequent amendment involves working with numerous stakeholders including states, commercial and recreational fishermen, conservation organizations, and academia. The fishery management plans prepared by the Councils are reviewed and approved by NOAA Fisheries (Department of Commerce), which is authorized to implement the M-S Act and all fisheries regulations.

The Gulf Council has developed seven FMPs. Two of the seven, coastal pelagics and spiny lobster, were developed jointly with the South Atlantic Fishery Management Council (SAFMC) due to the fact that the stocks of the species managed crosses into both regions. The other five

FMPs include reef fish, shrimp, stone crab, red drum, and coral and coral reefs. Combined, there are 55 species managed, excluding the coral complex (Section 3.4.1.2.2.7).

The original seven FMPs were developed between 1979 and 1986, and each has had a number of amendments added subsequently. Each of these amendments, their status and date of approval are listed below. The most recent amendment for any FMP includes an in-depth history of management for all the previous amendments and the original FMP, and all amendments are available directly from the Gulf Council. Appendix A of this document contains a complete summary of all management actions by the Gulf of Mexico Council for all seven FMPs.

The following section selects from the complete list those actions with direct benefits for fish habitat in the Gulf of Mexico, even if the justification of the action was not specifically habitat-related. To the degree that fish are considered as part of their habitat, management actions that prevent overfishing or rebuild overfished stocks will minimize or prevent adverse fishing impacts to this part of the habitat. Several FMPs contain programs for license limitation, license moratoria, and/or trap limitations. To the degree that these programs reduce fishing effort, they will also reduce potential adverse fishing impacts. The Reef Fish FMP has a moratorium and a scheduled phase out of fish traps, a moratorium on reef fish fishing permits, an endorsement and license limitation for red snapper, and a moratorium on headboats and charter boats. The Coastal Pelagics FMP has king mackerel moratorium and a head boat-charter boat moratorium. The Stone Crab FMP has a moratorium for traps. The Spiny Lobster FMP has trap limitations. Additional information on the history of management is provided in Section 3.2 Biological Environment and Section 3.3 Human Environment.

STATUS OF GULF Fishery Management Plans (and EISs).
* Joint FMP with the South Atlantic Fishery Management Council (SAFMC)
** SAFMC SFA Amendments

• **Coastal Pelagics (FEIS)***- FEBRUARY, 1983 - Amendment 1 (9/85) - Amendment 2 (7/87) - Amendment 3 (4/90) - Amendment 4 (10/89) - Amendment 5 (8/90) - Amendment 6 (12/92) - Amendment 7 (9/94) - Amendment 8 (4/98) - Amendment 9 (4/00) - Amendment 10 (partially approved)** - Amendment 11 (partially approved)** - Amendment 12 (10/00) - Amendment 13 EFH (8/02) **(SEIS)*** - Amendment 14 CBT (pending approval) • **Coral (FEIS)** - JULY, 1984 - Amendment 1 (2/91) - Amendment 2 (1/95) **(SEIS)** - Amendment 3 (11/95) - Amendment 4 (8/02) **(SEIS)** • **Reef Fish (FEIS)** - NOVEMBER, 1984 - Amendment 1 (2/90) - Amendment 2 (7/90) - Amendment 3 (7/91) - Amendment 4 (5/92) - Amendment 5 (2/94) **(SEIS)** - Amendment 6 (7/93) - Amendment 7 (2/94) - Amendment 8 (implementation withdrawn) - Amendment 9 (8/94) - Amendment 10 (withdrawn) - Amendment 11 (1/96) - Amendment 12 (12/96) - Amendment 13 (10/96) - Amendment 14 (4/97) - Amendment 15 (12/97) - Amendment 16A (12/99) - Amendment 16B (11/99) - Amendment 17 (8/00) - Amendment 18 (under development) **(SEIS)** - Amendment 19 (8/02) **(SEIS)** - Amendment 20 CBT (pending implementation) - Amendment 21 (under development) - Secretarial Amend 1 (under development) **(SEIS)** - Secretarial Amend 2 (pending implementation)	• **Red Drum (FEIS) –** DECEMBER, 1986 - Amendment 1 (10/87) - Amendment 2 (7/88) - Amendment 3 (10/92) - Amendment 4 (8/02) **(SEIS)** • **Shrimp (FEIS)–** MAY, 1981*** - Amendment 1 (11/81) - Amendment 2 (4/83) - Amendment 3 (8/84) - Amendment 4 (6/90) - Amendment 5 (7/91) - Amendment 6 (4/93) - Amendment 7 (1/95) - Amendment 8 (1/96) - Amendment 9 (5/98) **(SEIS)** - Amendment 10 (pending implementation) - Amendment 11 (9/02-12/02) - Amendment 12 (8/02) **(SEIS)** - Amendment 13 (under development) • **Spiny Lobster (FEIS)*** - JUNE, 1982 - Amendment 1 (7/87) - Amendment 2 (10/89) - Amendment 3 (4/91) - Amendment 4 (8/95) - Amendment 5 (partially approved)** - Amendment 6 (partially approved)** - Amendment 7 (8/02) **(SEIS)*** • **Stone Crab (FEIS)–** SEPTEMBER, 1979 - Amendment 1 (11/82) - Amendment 2 (9/84) - Amendment 3 (10/86) - Amendment 4 (4/91) - Amendment 5 (5/95) - Amendment 6 (9/98) - Amendment 7 (11/02) - Amendment 8 (8/02) **(SEIS)** • **Essential Fish Habitat** (EFH) - Amendment 1 (partially approved 2/99) - Amendment 2 (8/02) **(SEIS)** • **SFA Amendment** - (partially approved 11/99)

3.4.1.2.2.1 Red drum FMP

Management of red drum in the EEZ is oriented strongly toward catch reduction to reverse low abundance levels caused by overfishing the stock in the estuaries of the states. The Red Drum FMP and subsequent amendments did not call for management measures to specifically address red drum habitat issues. However, the continued reduction of harvest by Federal and Council actions through the 1980s (emergency regulations, the FMP, and Amendment 1) and prohibition of red drum retention from the EEZ in 1988 (Amendment 2) prevented any adverse red drum fishing impacts on red drum habitat in the EEZ. Amendment 2 also identified as management objectives for the Red Drum FMP that the Council work with the states to provide at least a 30% level of escapement of each year class juvenile red drum to the offshore spawning stock; establish, implement, and maintain research and data gathering programs to insure that the appropriate data is available to formulate management measures and monitor the condition of the stock; fairly allocate TAC between EEZ users should stocks improve to allow harvest; maximize the economic and social benefits of the resource to the nation; and identify and encourage actions resulting in the conservation, restoration, and enhancement of red drum habitat.

After Amendment 2 prohibited any harvest or possession of red drum in the EEZ all subsequent management actions were carried out by the states whose goal was to allow at least 30 percent escapement of each cohort (year class) to the offshore spawning stock after 2 to 4 years in the estuaries. To achieve this goal all the states prohibited commercial harvest, except Mississippi which had a small commercial quota (35,000 pounds), and each state drastically reduced recreational harvest. For example, Florida was changed from no bag limit and no commercial quota to no commercial fishery, a bag limit of 1 fish, a 3-month closure, and a slot limit of 18 to 27 inches. The other states implemented rules that significantly reduced recreational catch (Swingle, personal communication).

3.4.1.2.2.2 Reef Fish FMP

The reef fish fisheries have the largest group of species and the most diverse set of authorized gear of any of the Gulf of Mexico Council FMPs. The Council has taken more actions in the Reef Fish FMP to protect fish habitat than any of the FMPs. The Reef Fish Fishery Management Plan was implemented in November 1984. While the regulations from the FMP were designed to rebuild declining reef fish stocks, prohibitions on the use of fish traps, roller trawls, rock hopper trawls, and powerhead-equipped spear guns within an inshore stressed area had an indirect benefit of preventing any adverse fishing impacts in the stressed area.

Amendment 1 to the Reef Fish Fishery Management Plan, implemented in 1990, was a major revision of the original FMP. It set as a primary objective of the FMP the stabilization of long-term population levels of all reef fish species. Among the management measures implemented, the following resulted in gear restrictions or effort reductions that reduced adverse fishing impacts on fish habitat:

- Established a longline and buoy gear boundary inshore of which the directed harvest of reef fish with longlines and buoy gear was prohibited and the retention of reef fish captured incidentally in other longline operations (e.g., sharks) was limited to the

recreational bag limit. Subsequent changes to the longline/buoy boundary could be made through the framework procedure for specification of TAC;
- Limited trawl vessels (other than vessels operating in the unsorted groundfish fishery) to the recreational size and bag limits of reef fish;
- Established fish trap permits, allowing up to a maximum of 100 fish traps per permit holder;
- Prohibited the use of entangling nets for directed harvest of reef fish. Retention of reef fish caught in entangling nets for other fisheries is limited to the recreational bag limit;
- Extended the stressed area to the entire Gulf coast.

Amendment 4, implemented in May 1992, established a moratorium on the issuance of new reef fish permits for a maximum period of three years, and prevented further increases in reef fish participants.

Amendment 5, implemented in February 1994, established restrictions on the use of fish traps in the Gulf of Mexico EEZ, implemented a three-year moratorium on the use of fish traps, created a special management zone (SMZ) with gear restrictions off the Alabama coast, created a framework procedure for establishing future SMZs, and closed the region of Riley's Hump (near Dry Tortugas, Florida) to all fishing during May and June to protect mutton snapper spawning aggregations.

Amendment 14, implemented in March and April 1997, provided for a ten-year phase-out for the fish trap fishery, and prohibited use of fish traps west of Cape San Blas, Florida (85^{o} 30’ west longitude).

Amendment 15, implemented in January 1998, also prohibited harvest of reef fish from traps other than permitted reef fish traps, stone crab traps, or spiny lobster traps.

Amendment 16A, submitted to NOAA Fisheries in June 1998, was partially approved and implemented on January 10, 2000. The approved measures provided that the possession of reef fish exhibiting the condition of trap rash on board any vessel with a reef fish permit that is fishing spiny lobster or stone crab traps is prima facie evidence of illegal trap use and is prohibited except for vessels possessing a valid fish trap endorsement, and that NOAA Fisheries establish a system design, implementation schedule, and protocol to require implementation of a vessel monitoring system (VMS) for vessels engaged in the fish trap fishery.

Amendment 17 was submitted to NOAA Fisheries in September 1999, and was implemented on August 10, 2000. This amendment extended the commercial reef fish permit moratorium for another 5 years, from its previous expiration date of December 31, 2000 to December 31, 2005, unless replaced sooner by a comprehensive controlled access system. The purpose of the moratorium is to provide a stable environment in the fishery necessary for evaluation and development of a more comprehensive controlled access system for the entire commercial reef fish fishery.

In August 1990, a regulatory amendment was prepared that proposed establishment of a 1.0 million pound commercial red snapper quota and a 2-fish recreational red snapper daily bag limit for 1991-2002. It also proposed a May 31-July 31 closure for the shrimp trawl fishery for 1991-1992 to reduce red snapper bycatch by 27 percent, and require either additional closures or gear modifications beginning in 1993 to reduce red snapper bycatch by 64 percent overall. These measures were expected to restore the red snapper stock from a current estimate of 0.6 percent SPR to 20 percent SPR in the year 2002. The Council received over 9,000 public comments on the options under consideration, and the regulatory amendment, as written, was not submitted.

"Although the amendment was not submitted for implementation, it raised enough concern by Congressmen and Senators attending the public hearings that in the 1990 re-authorization of the Magnuson-Stevens Act they included a provision under Section 304(g) for Incidental Harvest Research. This section provided that the Secretary would initiate a research program that would, in part, characterize the bycatch occurring in the Shrimp Fisheries of the Gulf and South Atlantic, the effects of this bycatch on the stocks affected, and provide for development of technological devices that would reduce the incidental mortality of non-target species. It also provided the Secretary would not implement any measures to reduce bycatch until after January 1, 1994. The research program was implemented in 1991 and terminated in 1996. Subsequent to the 1990 public hearings Nichols (1990) judged that the 3-month closure of trawling proposed in the regulatory amendment was unlikely to provide any benefit because the juvenile red snapper were present on the shrimp grounds for their first 14 months and trawl fishing effort would be affected for only 3 months each year. An August 1999 regulatory amendment, implemented June 19, 2000, established two marine reserves on areas suitable for gag and other reef fish spawning aggregations sites that are closed year-round to fishing for all species under the Council's jurisdiction. The two sites cover 219 square nautical miles near the 40-fathom isobath, off west central Florida.

3.4.1.2.2.3 Coastal Migratory Pelagics FMP

The Fishery Management Plan for Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic (FMP) and EA, approved in 1982 and implemented by regulations effective in February of 1983, treated king and Spanish mackerel each as one U.S. stock.

Amendment 3 with EA, was partially approved in 1989, revised, resubmitted, and approved in 1990. It prohibited drift gill nets for coastal pelagics and purse seines for the overfished groups of mackerels.

Amendment 5 with EA, implemented in August 1990, made a number of changes in the management regime, among which specified that Gulf group king mackerel may be taken only by hook-and-line and run-around gill nets.

3.4.1.2.2.4 Shrimp FMP

The shrimp fishery FMP in the Gulf of Mexico was prepared by the Gulf of Mexico Fishery Management Council (GMFMC) and implemented as Federal regulation on May 15, 1981. The principal thrust of the plan was to enhance yield in volume and value by deferring harvest of small shrimp to provide for growth. Principle action included: (1) establishing a cooperative Tortugas Shrimp Sanctuary with the state of Florida to close a shrimp trawling area where small pink shrimp comprise the majority of the population most of the time; (2) a cooperative 45-day seasonal closure with the state of Texas to protect small brown shrimp emigrating from bay nursery areas; and (3) seasonal zoning of an area of Florida Bay for either shrimp or stone crab fishing to avoid gear conflict. These actions have indirect benefits for shrimp habitat. Permanent closures, such as in the Tortugas, prevent any adverse shrimp fishing impacts in the closed areas. Seasonal zoning of Florida Bay and the Texas closure remove shrimp fishing activity from these areas and prevent adverse fishing impacts during those periods. Amendment 9, implemented in May 1998, addressed the issue of reducing bycatch of juvenile red snapper and other finfish by requiring trawls fished in the EEZ west of Cape San Blas, Florida (85° 30' west longitude) to be equipped with bycatch reduction devices (BRDs). Amendment 10, submitted for review, approval, and implementation, will extend the requirement for BRDs to the eastern Gulf. NOAA Fisheries, in 1989/1991, required all shrimp trawls used in the Gulf to be equipped with TEDs to eliminate the bycatch of turtles classified as threatened or endangered under the ESA.

3.4.1.2.2.5 Stone Crab FMP

The Fishery Management Plan for the Stone Crab Fishery of the Gulf of Mexico (FMP) was implemented on September 30, 1979 (44 FR 53519). The FMP resolved a conflict over competing gear use between stone crab and shrimp fishermen operating in the Exclusive Economic Zone (EEZ) off southwest Florida and extended Florida's rules regulating the fishery into the EEZ. The management area of the FMP is limited to the EEZ seaward of the west coast of Florida in the Gulf of Mexico (Gulf). The FMP and compatible state action created MPAs totaling about 10,360 square km (4,000 square miles) where shrimp trawling is prohibited permanently (about 2,500 square nautical miles) or seasonally (about 1,500 square nautical miles).

Amendment 1 was implemented on November 8, 1982 (47 FR 41757), and specified a procedure for modifying the zoned area to resolve the gear conflict.

Amendment 2 was implemented on August 31, 1984 (49 FR 30713), and established procedures for resolving gear conflicts in central west Florida. This amendment established MPAs totaling about 170 square nautical miles where shrimp trawling is permanently prohibited.

Amendment 5 also updated the description of the fishery habitat and the factors affecting this habitat.

Amendment 7, which was implemented in November 2002, provides for a trap limitation system that, in cooperation with the trap limitation system implemented by the state of Florida in 2000, will, over time, significantly reduce the number of traps deployed in the fishery. The program functions like an ITQ program except whenever trap certificates are sold, transferred, or traded, the number of certificates will be reduced.

3.4.1.2.2.6 Spiny Lobster FMP

The Fishery Management Plan for Spiny Lobster in the Gulf of Mexico and South Atlantic (FMP) was implemented on July 2, 1982 (47 FR 29203). The FMP largely extended Florida's rules regulating the fishery to the EEZ throughout the range of the fishery, i.e. North Carolina to Texas. The management measures included prohibiting use of spears or hooks.

A regulatory amendment, implemented in 1992, established a trap certificate program that jointly, with the trap certificate program implemented by the state of Florida, has significantly reduced the number of traps deployed in the fishery from about 800,000 to about 530,000 at the start of the 1999/2000 season. This program will continue to reduce the number of traps until the optimum level is reached (Hunt *et al*. 1999).

3.4.1.2.2.7 Coral FMP

The FMP/DEIS, completed in 1982, described the coral communities throughout the jurisdictions of the Gulf and South Atlantic Councils. The FMP prohibited harvest of stony coral and seafans except by scientific permit. It established Habitat Areas of Particular Concern (HAPC) in the Gulf and Atlantic where the use of any fishing gear interfacing with the bottom was prohibited. It regulated the use of chemicals used by fish collectors near coral reefs.

Amendment 1, completed in 1990, established the total allowable harvest (TAC) for commercial harvestors of gorgonians (soft coral) at 50,000 colonies annually.

Amendment 2, implemented December 21, 1994, established area closures, gear restrictions, and a phase-out of harvest of wild live rock by 1997. This prohibited the landing of coral reef rubble with live rock organisms attached and required all landings to be from supervised aquaculture using substrates readily distinguishable from coral rubble, which in itself is important EFH. Before this action, up to about 500,000 pounds of coral rubble-based live rock was being landed annually by the tropical fish industry.

Amendment 3 was prepared by the Gulf of Mexico Council to provide additional management to the harvest of live rock in the Gulf of Mexico. This amendment considers further live rock regulation including an annual quota during phase-out, revision of trip limits, closed area off Florida's Panhandle, redefinition of allowable octocorals, and limited personal use live rock harvest.

3.4.1.2.2.8 Other Council Activities

Under the FMPs listed above, the Council established a number of marine protected areas (MPAs) that are discussed under Section 3.5.1.

A Generic Amendment Addressing the Establishment of the Tortugas Marine Reserves was implemented in 2001 (GMFMC 2000) is described in Section 3.4.1.2.2.2. This generic amendment applied to all seven Gulf of Mexico FMPs: Red Drum Amendment 4, Reef Fish Amendment 19, Coastal Migratory Pelagics Amendment 13, Shrimp Amendment 12, Stone Crab Amendment 8, Spiny Lobster /Amendment 7, and Coral Amendment 4. The goals of the actions taken in this amendment were taken to conserve and increase habitat for reef fish, to increase reef fish populations and provide protection for juveniles, and to minimize, as appropriate, adverse human impacts on coral and coral reefs. This generic amendment created two marine reserves, in cooperation with FKNMS, that total about 185 square nautical miles.

A Generic Amendment for Essential Fish Habitat was partially approved in 1999; no regulations resulted from the amendment. The generic amendment describes the habitat constituting that essential for each life history stage of 26 representative species, which result in most of the landings from the Gulf. It describes the habitat types and distribution, threats to these habitats, predator-prey relationships, factors resulting in EFH losses, conservation and enhancement measures for EFH, and recommendations to minimize impacts from non-fishing threats.

A Generic Amendment to address SFA provisions to prevent overfishing and rebuild overfished stocks was partially approved in 1999. The generic amendment provided demographic and economic information on fishing communities. It proposed scientific definitions for each stock managed by the Council for: MSY, OY, Maximum Fishing Mortality Thresholds (MFMT), and for Minimum Stock Size Thresholds (MSST). It proposed rebuilding plans for overfished stocks for which such data were available. It assessed bycatch and proposed reporting requirements for bycatch.

3.4.1.3 Endangered Species Act (16 U.S.C. Section 1531 et seq.)

The Endangered Species Act (ESA) protects animals and plants threatened with extinction. When a project is proposed that affects a listed threatened or endangered species, the ESA requires all regulatory agencies to consult with the Fish and Wildlife Service (or NOAA Fisheries) prior to issuing any permit or taking any other action that would harm the listed species. Once a species is listed, the ESA prohibits the ‘taking’ of that species by direct or indirect actions. The definition of ‘taking’ may include harming that species through destruction of habitat. The FWS or NOAA Fisheries complete a formal consultation report after determining the impact of the project on that species and recommend measures, that may include denial of the permit, to reduce or eliminate the threat posed by the project or activity.

Although no species managed under the seven Gulf of Mexico FMPs are listed as threatened or endangered, four species are on the NOAA Fisheries’ candidate list of species for possible future listing. These species are speckled hind (*Epinephelus drummondhayi*), Goliath grouper (formerly known as jewfish) (*E. itijara*), Warsaw grouper (*E. nigritus*), and Nassau grouper (*E. striatus*).

Species presently listed under the ESA, which occur in the regularly Gulf include sperm whales, fin whales, west indian manatees, five species of sea turtles (green, hawksbill, Kemp’s ridley, leatherback, and loggerhead), Gulf sturgeon, and smalltooth sawfish (see Section 3.2.6). Listed species which occur rarely and are believed to be strays include right whales, blue whales, sei whales, and humpback whales.

3.4.1.4 Marine Mammal Protection Act (16 U.S.C. 1361 et seq.)

The Marine Mammal Protection Act (MMPA) established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, and on the importing of marine mammals and marine mammal products into the United States. Under the MMPA, the Secretary of Commerce (authority delegated to NOAA Fisheries) is responsible for the conservation and management of cetaceans and pinnipeds (other than walruses). The Secretary of the Interior is responsible for walruses, sea and marine otters, polar bears, manatees and dugongs.

Part of the responsibility that NOAA Fisheries has under the MMPA involves monitoring populations of marine mammals to make sure that they stay at optimum levels. If a population falls below its optimum level, it is designated as "depleted," and a conservation plan is developed to guide research and management actions to restore the population to healthy levels.

In 1994, Congress amended the MMPA, to govern the taking of marine mammals incidental to commercial fishing operations. This amendment required the preparation of stock assessments for all marine mammal stocks in waters under U.S. jurisdiction, development and implementation of take-reduction plans for stocks that may be reduced or are being maintained below their optimum sustainable population levels due to interactions with commercial fisheries, and studies of pinniped-fishery interactions.

The MMPA requires all commercial fisheries to be placed in one of three categories, based on the relative frequency of incidental serious injuries and mortalities of marine mammals in each fishery. Category I designates fisheries with frequent serious injuries and mortalities incidental to commercial fishing; Category II designates fisheries with occasional serious injuries and mortalities; Category III designates fisheries with a remote likelihood or no known serious injuries or mortalities. The Gulf of Mexico Federal fisheries assessed in this EIS for the EFH Amendment are presently all listed as Category III fisheries. NOAA Fisheries is proposing to elevate the Gulf of Mexico gillnet fishery, however, to Category II based on documented interactions with Gulf of Mexico stocks of bottlenose dolphins (68 FR 1414). The gulf of Mexico gillnet fishery includes the Gulf of Mexico inshore gillnet, Gulf of Mexico coastal gillnet, and the Gulf of Mexico king and spanish mackerel gillnet fisheries." The Gulf of Mexico king and spanish mackerel fisheries are managed under the Coastal Migratory Pelagic Resources FMP.

Although it is a state fishery, the menhaden fishery is listed as a Category II. The blue crab trap/pot fishery, while listed as a Category III, does have documented marine mammal takes.

3.4.1.5 Federal policy on artificial reefs

A National Artificial Reef Plan, developed under the Secretary of Commerce by direction of the National Fishing Enhancement Act of 1984 and the Environmental Protection Agency based upon Federal and international law, provides guidance for development of artificial reefs. Also, guidance is provided by the Coastal Artificial Reef Planning Guide adopted by the Gulf, Atlantic, and Pacific States Marine Fisheries Commissions, and Guidelines for Marine Artificial Reef Materials produced by the Gulf States Marine Fisheries Commission.

The Gulf States, Atlantic States, and Pacific States Marine Fisheries Commissions asked NOAA Fisheries to allow the states to develop revisions to the National Artificial Reef Plan. The revised plan places stronger emphasis on the habitat implications of artificial reefs than on other functions or outcomes. The revised plan does not list approved material for artificial reef construction, but specifies criteria for materials. The revised plan recommends that only state marine fisheries management agencies hold artificial reef permits, to ensure compatibility with fishery management plans, and to provide a permanent entity to assume liability. The revised plan also recommends conducting baseline and follow-up evaluations and monitoring to determine if reefs meet objectives set for them. Under the revised plan, artificial reefs may be used to restore and enhance habitat, as sanctuaries, as reef management areas for effort control, or to resolve spatial and use-conflict.

A cooperative program among the MMS, NOAA Fisheries, Texas A&M University, and the oil industry developed a program to increase understanding of the recreational use of oil and gas platforms (MMS 2000). The cooperative program had five objectives: 1) to develop a national policy that recognizes the artificial reef benefits of oil and gas platforms; 2) to prepare a Rigs-to-Reefs (RTR) program plan for the Gulf of Mexico; 3) to establish a standard procedure to ensure and facilitate timely conversion of obsolete platforms as reefs; 4) to identify research and studies necessary to optimize the use of platforms as reefs; and 5) to identify legal restrictions that may prevent use of obsolete platforms as artificial reefs.

3.4.1.6 Non-fishery specific management laws & regulations

The implementation of a number of Federal, state, and local laws, regulations, and policies have a direct effect on habitat and waters that may be considered essential habitat or habitat areas of particular concern to the fish species managed by the Gulf of Mexico Fishery Management Council and NOAA Fisheries. As mentioned in the beginning of Section 2, the designation of essential fish habitat (EFH) allows the Council and NOAA Fisheries to intervene in decisions on non-fishing activities that may affect essential habitat, and requires other Federal agencies with responsibility for proposed non-fishing actions to consult with NOAA Fisheries on projects with potential adverse impacts on EFH. The responsible Federal agency must respond in writing to NOAA Fisheries with the rationale for whatever mitigation it authorizes. State, local, and non-Federal entities are not required to consult with NOAA Fisheries and the Council regarding the effects of actions on EFH, if those activities do not require Federal licenses, permits, or funding.

The following laws and regulations are those that permit non-fishing activities for which the Council and NOAA Fisheries may potentially intervene. Brief descriptions of the intent of the law is provided. Much of these descriptions have been taken from *A Guide to Protecting Wetlands in the Gulf* (Goldberg, *et al*. 2001).

3.4.1.6.1 The Clean Water Act (33 U.S.C. Section 1251 et seq.)

In 1972, Congress passed the Clean Water Act (CWA) - also known as the Water Pollution Prevention and Control Act - to protect the quality of the nation's waterways including oceans, lakes, rivers and streams, aquifers, coastal areas, and wetlands. The law sets out broad rules for protecting the waters of the United States; Sections 401 and 404 apply directly to waters and wetlands protection.

3.4.1.6.1.1 Section 404 of the Clean Water Act

Section 404 of the Clean Water Act (often referred to as "Section 404" or simply "404") forbids the unpermitted "discharge of dredge or fill material" into waters of the United States. Section 404 does not regulate every activity in wetlands or coastal areas, but requires anyone seeking to fill any area to first obtain a permit from the Army Corps of Engineers (ACOE). Constructing bridges, causeways, piers, port expansion, or any other construction or development activity along a waterway or in a wetland generally requires a 404 permit. When a fill project is permitted, there is usually mitigation required to compensate for damaged or destroyed wetlands.

3.4.1.6.1.2 Section 401 of the Clean Water Act

Section 401 of the Clean Water Act requires that an applicant for a Section 404 permit, obtain a certificate from their state's environmental regulatory agency that the activity will not negatively impact water quality. This permit process is supposed to prevent the discharge of pollutants (pesticides, heavy metals, hydrocarbons) or sediments into waters, that may be above acceptable levels, because decreased water quality may endanger the health of the people, fish, and wildlife. However, acceptable pollutant levels have not been established for many wetlands, which makes it difficult for state agencies to fully assess a project's impact on water quality.

3.4.1.6.1.3 National Estuary Program

The National Estuary Program, established by Congress in 1987 by amendments to the Clean Water Act, identifies estuaries of national significance and establishes a management conference to develop a comprehensive management plan for the estuary. The management conference often involves representatives from NOAA Fisheries. It is given the responsibility to: assess and characterize trends in water quality, pollutants, natural resources, uses of the estuary, and causes of environmental problems; develop a Comprehensive Conservation and Management Plan (CCMP) that recommends priority corrective actions and compliance schedules addressing point and nonpoint sources of pollution to restore and maintain the chemical, physical, and biological integrity of the estuary, including restoration and maintenance of water quality, and a balanced indigenous population of shellfish, fish, and wildlife.

Implementation of the CCMP is completely voluntary, rather than regulatory, but the process allows consideration and incorporation of many issues such as protection or restoration of EFH. Additionally, similar to the language in the Coastal Zone Management Act, the management conference is supposed to review all Federal financial assistance programs and development projects in accordance with the requirements of Executive Order 1372, as in effect on September 17, 1983, to determine whether such assistance program or project would be consistent with, and further the purposes or objectives of the CCMP.

There are seven National Estuary Programs around the Gulf of Mexico. These include the Coastal Bends and Galveston Bay in Texas; Barrataria-Terrebonne in Louisiana; Mobile Bay in Alabama; and Tampa Bay, Sarasota Bay, and Charlotte Harbor in Florida.

3.4.1.6.2 Section 10 of The Rivers and Harbors Act (33 U.S.C. Section 403)

The Rivers and Harbors Act was created in 1899 to prevent navigable waters of the United States from being obstructed. Section 10 of the Act requires that anyone wishing to dredge, fill, or build a structure in any navigable water and associated wetlands obtain a permit from the ACOE. An activity affecting wetlands may require a Section 404 and Section 10 permit, thus both sections are often included together in a permit notice. When these activities are permitted, and there is direct loss of submerged habitat, such as seagrasses, then mitigation is often required to compensate for this loss.

3.4.1.6.3 The Coastal Zone Management Act (16 U.S.C. Section 1456(c))

In 1972, Congress passed the Coastal Zone Management Act (CZMA) to protect the nation's coasts by helping states regulate activities in the coastal zone. The CZMA encourages states to voluntarily develop management programs to manage and balance competing uses of, and impacts to, coastal resources. The programs are embodied in state Coastal Zone Management Program (CZMP) Plans that are submitted for Federal approval. The program is administered at the Federal level by the Coastal Programs Division (CPD) within NOAA's Office of Ocean and Coastal Resource Management (OCRM). All five of the coastal states bordering the Gulf currently have approved coastal management programs. The coastal zone generally extends 3 miles seaward (state waters) and inland as far as necessary to protect the coast. In the Gulf of Mexico, state waters for both Texas and Florida extend approximately 9 miles (9 nm). States with approved CZMPs receive Federal funding to help them protect and improve the quality of their coastal areas.

Section 307 of the CZMA, called the Federal Consistency provision, is a major incentive for States to join the national coastal management program and is a tool states use to manage coastal uses and resources and to facilitate cooperation and coordination with Federal agencies. Federal Consistency is a requirement that Federal actions that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone must be consistent with the enforceable polices of a state's Federally approved CZMP. Federal actions consist of three categories:

1. Federal agency activities—activities and development projects performed by a Federal agency, or a contractor for the benefit of the Federal agency (e.g. Fishery Management Plans, disposal of Federal land by the General Services Administration, U.S. Army Corps of Engineers beach nourishment projects, etc.);
2. Federal license or permit activities—activities not performed by a Federal agency, but requires Federal permits, licenses or other forms of Federal approval (e.g. Section 404 permits, Corps permits for ocean dump-sites, etc.); and
3. Federal financial assistance to State and local governments. (e.g. Federal Highway Administration funds, Housing and Urban Development grants, etc.)

Each state has a procedure for Federal Consistency reviews and includes an opportunity to obtain comments from state and local agencies, as well as the public. FMP-related actions are identified as a Federal agency activity and therefore subject to the Federal Consistency provisions. The Gulf Council and NOAA Fisheries should contact each State CZMP early, prior to taking any action on FMP Amendments, to ensure early coordination and consultation. If coastal effects are reasonably foreseeable, then a Consistency Determination will be submitted to the State CZMP at least 90 days prior to taking any action. The Consistency Determination must include a detailed description of the activity, its expected coastal effects, and an evaluation of the proposed activity in light of applicable enforceable policies in each State's CZMP. If there are no effects, the Council and NOAA Fisheries can provide a Negative Determination. Each State CZMP has 60 days to concur with or object to the Consistency Determination. If the State agrees with the Consistency Determination, then the Council and NOAA Fisheries may proceed immediately with their action. If the State objects, the State must describe how the proposed activity is inconsistent with enforceable CZMP policies. Early contact with State CZMPs should be directed toward resolving any differences.

3.4.1.6.3.1 National Estuarine Research Reserves System

The National Estuarine Research Reserves System was established by the Coastal Zone Management Act of 1972, as amended. It is a network of 25 protected areas that represent different biogeographic regions of the United States. It helps to fulfill NOAA's stewardship mission to sustain healthy coasts by improving the nation's understanding and stewardship of estuaries.

Each reserve is a "living laboratory" in which scientists conduct research and educators communicate research results. Reserve staff members work with local communities and regional groups to address natural resource management issues, such as nonpoint source pollution, habitat restoration and invasive species. Four NERRs are established in the Gulf of Mexico: Apalachicola Bay and Rookery Bay in Florida; Weeks Bay Reserve in Alabama, and Grand Bay in Mississippi.

3.4.1.6.4 The Coastal Wetlands Planning, Protection, and Restoration Act (Public Law 101-646, Title III)

The Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) of 1990 sets aside millions of dollars every year for voluntary wetland restoration projects in coastal states. The state of Louisiana receives approximately 70% of the funding from CWPPRA, while other states may receive money through wetland conservation grants from the U.S. Fish and Wildlife Service, or from the Secretary of the Interior under the North American Wetlands Conservation Act. Agencies and citizens can take part in the CWPPRA process by proposing projects of local concern and providing input on proposed restoration projects. Local ACOE district offices and regional Fish and Wildlife Service offices maintain information on projects being funded under CWPPRA.

3.4.1.6.5 The Fish and Wildlife Coordination Act (16 U.S.C. 661, 666c)

The Fish and Wildlife Coordination Act protects the quality of the aquatic environment needed for fish and wildlife resources. The Act requires the Federal agencies to consult with the FWS or NOAA Fisheries to ensure that the environmental value of a body of water or wetland is taken into account in the decision-making process as they review permit applications and proposals for Federal construction. Consultation is generally initiated when the agency sends the FWS or NOAA Fisheries a public notice of an action. FWS or NOAA Fisheries may file comments on the productivity stating concerns about the negative impact the activity will have on the environment and suggesting measures to reduce the impact.

It is through this mechanism that the NOAA Fisheries' Habitat Conservation Division reviews actions for their potential impact on fish habitat (since the early 1980s) and since the M-S Act reauthorization, on EFH as well. NOAA Fisheries staff makes recommendations to prevent, minimize or mitigate adverse impacts on EFH. In 2000 and 2001, more than 2,700 proposed development actions in the five Gulf states[54] were reviewed annually by NOAA Fisheries (Ruebsamen, pers. communication). A historical overview of development activities in each of the Gulf states from 1982 through 2001 that were reviewed annually by NOAA Fisheries Habitat Conservation Division is presented in Table 3.4.1.

There are no clear trends in amount of activity; the two years with more than 3500 actions reviewed were 1982 and 1997. It does not appear that more actions have been reviewed by NOAA Fisheries since the changes in the M-S Act. Since 1997, after the peak mentioned, actions reviewed declined to a low of 2630 in 1999, and increased just slightly to more than 2,700 as mentioned above.

3.4.1.6.6 Title III of the Marine Protection, Research and Sanctuaries Act of 1972

The National Marine Sanctuaries Program was created in Title III of the Marine Protection, Research and Sanctuaries Act of 1972. Today, there are 13 national marine sanctuaries protecting some 48,000 square km (18,500 square miles) of ocean and coasts. Of these, two are located in the Gulf of Mexico: the Flower Gardens Banks and Florida Keys National Marine Sanctuaries.

[54] Numbers for the Gulf coast of Florida are an estimated subset of actions statewide.

The Flower Garden Banks National Marine Sanctuary was designated on January 17, 1992. The area containing both the East and West Banks equals 41.7 snm in size and contains 142 ha of reef crest. Four years later in October 1996, Congress expanded the sanctuary by adding a small third bank. Stetson Bank, also a salt dome, measures about 800m long and 300m wide and is located about 70 nm south of Galveston, Texas.

The waters immediately surrounding the entire archipelago (1,700 islands) of the Florida Keys have been designated as a national marine sanctuary since 1990. It includes the productive waters of Florida Bay, the Gulf of Mexico and the Atlantic Ocean, and cultural resources are also contained within the sanctuary. The sanctuary extends 220 miles in a northeast to southwest arc between the southern tip of Key Biscayne, south of Miami, to beyond, but not including, the Dry Tortugas Islands. Authorized by Congress, this 2,800 snm sanctuary was established to stem mounting threats to the health and ecological future of the coral reef ecosystem.

Staff from NOAA Fisheries are involved in the Federal management teams that develop the sanctuary management plans to ensure coordination with regard to fisheries management, and protection of vital fishery resources and fishery habitats.

3.4.2 State laws and policies

3.4.2.1 State fishery management

Each of the five Gulf States exercises legislative and regulatory authority over their states' natural resources through discrete administrative units. Although each agency listed below is the primary administrative body with respect to the states natural resources, all states cooperate with numerous state and Federal regulatory agencies when managing marine resources. A brief description of each states primary regulatory agency for marine resources is provided below.

3.4.2.1.1 The Texas Parks & Wildlife Department

The Texas Parks and Wildlife Department (TPWD) provides outdoor recreational opportunities by managing and protecting wildlife and wildlife habitat and acquiring and managing parklands and historic areas. It has inherited the functions of many state entities created to protect Texas' natural resources. In 1895 the legislature created the Fish and Oyster Commission to regulate fishing. In 1951, the term oyster was dropped from the wildlife agency's name, and in 1963, the Parks Board and the Game and Fish Commission were merged to form the Texas Parks and Wildlife Department. The legislature placed authority for managing fish and wildlife resources in all Texas counties with the Parks and Wildlife Department when it passed the Wildlife Conservation Act in 1983. Previously, commissioners' courts had set game and fish laws in many counties, and other counties had veto power over department regulations (TPWD, 2002).

The goal of the TPWD is to manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations. The agency currently has ten internal divisions: Wildlife, Coastal

Fisheries, Inland Fisheries, Law Enforcement, State Parks, Infrastructure, Resource Protection, Communications, Administrative Resources, and Human Resources. Three senior division directors provide special counsel to the Executive Director in the areas of water policy, land policy and administrative matters. Intergovernmental affairs and internal audit and investigations are administered through the Executive Office.

The Texas Parks and Wildlife Commission consists of nine members appointed by the Governor with the advice and consent of the Senate. Commission members serve staggered terms of six years, with the terms of three members expiring every two years. The terms expire on January 31 of odd-numbered years, and Commission members hold office until successors are appointed and qualified.

Every two years, the governor selects from among the members a Chairman of the Commission for a term expiring on January 31 of the succeeding odd-numbered year. The commission elects a Vice-Chairman from among its members to serve a two-year term. Vacancies on the Commission are filled by the Governor, and vacancies in the office of Chairman and Vice-Chairman are filled in the same manner as the original appointment or election.

The commission may meet as often as necessary, but at least on a quarterly basis. Five members constitute a quorum. The Commission's chief responsibility is the adoption of policies and rules to carry out all programs of the Parks and Wildlife Department. The Commission approves the biennial budget and appropriation requests for submission to the legislature sets departmental policy, and appoints an Executive Director charged with the implementation of that policy and operation of the department on a daily basis.

The Executive Director serves as the Agency's Chief Executive Officer and is accountable to the commission for the overall operation of the department and acts as liaison between the commission and the staff in accordance with established policies. The Executive Director acts as official representative of the department with the public and has responsibility to ensure compliance with all Commission policies and state and Federal laws and regulations concerning the department.

The Coastal Fisheries Division manages the marine fishery resources of Texas' 1.62 million ha of saltwater, including the bays and estuaries and out to nine snm in the Gulf of Mexico. Coastal Fisheries management strategies are directed toward optimizing the long-term utilization of the marine resources of Texas. This management is designed to sustain fisheries harvest at levels that are necessary to ensure replenishable stocks of commercially and recreationally important species and to provide for balanced food webs within Texas marine ecosystems. Technical data to assess population levels and develop appropriate fishing regulations are collected through coastwide, year-round standardized monitoring programs. In addition, life history studies and genetic research provide state-of-the-art knowledge for enhancing fishery stocks. Three world-class hatchery facilities directly enhance populations of several game fish to increase abundance and help offset impacts of natural catastrophes. The Coastal Fisheries staff work closely with other department divisions as well as Federal and international fishery management agencies to provide optimum opportunities from and conservation for the biological diversity inherent in Texas' marine waters.

Resource Protection Division protects Texas fish, wildlife, plant and mineral resources from degradation or depletion. The division investigates any environmental contamination that may cause loss of fish or wildlife. It provides information and recommendations to other government agencies and participates in administrative and judicial proceedings concerning pollution incidents, development projects and other actions that may affect fish and wildlife. The division works with the U.S. Army Corps of Engineers in protecting wetland areas and disposing of dredged material from Texas bays. The division leads the agency research and coordination efforts on in-stream flow issues for Texas' streams to ensure that adequate water reaches Texas rivers, bays and estuaries.

The Law Enforcement Division provides a comprehensive statewide law enforcement program to protect Texas' wildlife, other natural resources, and the environment. Texas Game Wardens are responsible for enforcement of the Parks and Wildlife Code, all TPW regulations, the Texas Penal Code and selected statutes and regulations applicable to clean air and water, hazardous materials and human health. Wardens fulfill these responsibilities through educating the public about various laws and regulations, preventing violations by conducting high visibility patrols, and apprehending and arresting violators. The Law Enforcement Division employs about 500 wardens throughout the state and operates 27 field offices that sell licenses, register boats, and provide the public with local information across the state (TPWD, 2002). For additional information see http://www.tpwd.state.tx.us/

3.4.2.1.2 The Louisiana Department of Wildlife and Fisheries

It is the mission of the Louisiana Department of Wildlife and Fisheries (LDWF), Marine Fisheries Division to conserve and protect Louisiana's renewable aquatic resources for present and future generations of Louisiana citizens by controlling harvest, and by replenishing and enhancing stocks and habitat. This is accomplished by setting seasons, size and possession limits, gear restrictions, or other means of protecting key resources; replenishing species and enhancing or developing species or habitats, as needed, to provide for the needs of consumptive and non-consumptive users or environmental health. Research provides insights into the proper functioning of natural systems, education of the public, and promoting the wise use of these resources (LDWF 2000).

Programs within the Marine Fisheries Division include: Crustacean (shrimp and crabs), Mollusk (oyster), Finfish, Habitat, Coastal Ecology, and Research. The clients served by these programs include present and future generations of Louisiana citizens, as well as national and international interests that derive benefits from consumptive and non-consumptive use of Louisiana's fisheries resources (LDWF 2000).

The Marine Laboratory's primary mission is to conduct the research required to manage Louisiana's marine fisheries. Laboratory facilities are also made available for the use of other Department and non-department entities engaged in fisheries management and enforcement, coastal restoration, and marine education. Gray snapper and gray triggerfish were recently added to those species sampled for age and growth analysis by the marine laboratory. Personnel obtain fish measurements and otoliths (ear stones) through fishery independent sampling and by sampling the commercial and recreational fisheries.

The Enforcement Division routinely uses the laboratory as a base of operations, and part of the marine training of Enforcement cadets is conducted at the laboratory each spring. Several LSU, UL Lafayette, and Nicholls State University researchers make use of laboratory facilities. The Department conducts a teacher workshop (Wetshop) at the laboratory each summer, and in conjunction with LSU Sea Grant and Agricultural Extension, also conducts the award-winning Marsh Maneuvers for 4 H students, each summer. The marine laboratory also supports the monitoring of the Grand Isle Sulphur Mine Reef for the Louisiana Artificial Reef Program (LDWF 2000).

The Louisiana shrimp fishery is its largest commercial fishery, accounting for over 85% of the value of the state's edible fisheries production. The fishery is based on two species, white and brown shrimp. Three other species are also harvested to a much lesser degree: sea bobs, pink shrimp and royal red shrimp (LDWF 2000).

The Louisiana Legislature has placed the shrimp fishery under the supervision and control of the Louisiana Wildlife and Fisheries Commission. The Commission has the authority to set seasons based on technical and biological data, which indicate that marketable shrimp, in sufficient quantities, are available for harvest. The Legislature has reserved to itself the right to determine legal gear, licenses and fees, legal sizes, and other aspects of the fishery (LDWF 2000).

A comprehensive monitoring program was developed in 1985 to protect or enhance these valuable resources, by providing information regarding the status of fish stocks that occur in the coastal waters of Louisiana, at some time during their life cycle. Several gear types are used coastwide to sample various year classes of estuarine-dependent fish.

The Marine Fisheries Division has conducted a continuous long-term fishery-independent monitoring program throughout coastal Louisiana since the early 1960s. Samples are taken coastwide utilizing 1.76 and 4.7 m trawls as well as 0.5 m plankton nets. Hydrological and climatological parameters critical to shrimp development, growth and survival are measured and recorded in conjunction with each sample. Additionally, a series of data collection platforms (DCP's) located in remote coastal areas transmit hourly readings of conductivity, salinity, water temperature and tidal elevations. These data are used to develop seasonal framework recommendations for both the spring and fall inshore shrimp seasons, special shrimp seasons, season extensions, and offshore territorial sea closures (LDWF 2000). Additional information on LDWF is available at http://www.wlf.state.la.us.

3.4.2.1.3 The Mississippi Department of Marine Resources

The Mississippi State Legislature created the Mississippi Commission of Marine Resources and the associated Department of Marine Resources in 1994. Historically, the management of the state's marine resources dates back to 1896 when county boards of supervisor's were accorded management authority. Chapter 58 of the Laws of 1902 created the Mississippi Oyster

Commission, which assumed the responsibility for managing these resources until 1930 when the 30-year reign of the Mississippi Seafood Commission began. In 1960 the state legislature created the Mississippi Marine Conservation Commission to manage the state's marine fisheries; and in 1970, the Mississippi Marine Resources Council was created to implement the state's Wetlands Protection Law and to develop and implement a Coastal Zone Management program. The merger of these two agencies in 1978 created the Mississippi Bureau of Marine Resources as an umbrella agency of the Department of Wildlife, Fisheries and Parks. The enabling legislation that resulted in the separate Department of Marine Resources recognized the importance of the state's marine resources (Jude LeDoux, MS DMR, personal communication 2002).

The Department is governed by a five-member commission and staffed with a team of marine biologists, coastal ecologists, engineers and other specialists. The Executive Director and Commissioners are all appointed by the Governor of Mississippi, and attend meetings once a month in a public setting. The Department also works with the Office of Naval Research, using side-scan sonar systems to map the oyster reefs and other bathymetry features in the Western Sound (DMR Annual Report 2000).

Additionally, the Department works with the John C. Stennis Space Center using remote sensing satellite imagery to review water quality and other environmental parameters. This technology allows for advance warning of red tides and other phenomena. In concert with the Office of Naval Research, the U.S. Geological Survey, the Environmental Protection Agency's Gulf of Mexico Program Office, U.S. Army Corps of Engineers, Institute of Marine Sciences, and other members of the marine scientific and regulatory communities, the DMR collects data that are useful in determining hazardous material spill trajectories, and also assists with marine patrol rescue missions, and other environmental concerns (DMR Annual Report).

The Department is also responsible for maintaining the high quality of Mississippi's seafood harvest, through the use of fishing regulations and monitoring of the water quality in harvest areas. Coastal management concerns include regulating shore development, maintaining non-point source runoff standards, and overseeing sewage treatment improvements (DMR Annual Report).

The Department of Marine Resources organization is based on legislative mandates assigned to the Commission and Department, as well as findings in a number of PEER and internal Department of Wildlife and Fisheries reports conducted over the past ten years (DMR Annual Report).

The principal function the DMR's Marine Fisheries Department is the design and initiation of projects which collect and analyze data required for population dynamics estimates and other fisheries management-related projects. The Marine Fisheries Department also develops management recommendations based on specific criteria, and monitor the existing condition of the stocks and fisheries that depend on them. The Marine Fisheries Department also provides information transfer and liaison activities with regional fisheries management entities and other stakeholders. The Marine Fisheries office provides technical support to the Mississippi Commission on Marine Resources in developing fishery management plans, amendments, stock assessments, and technical analysis. The Marine Fisheries Department also provides a representative to serve on fisheries-related boards, committees, and panels. Finally, the Marine Fisheries Department finally provides for the administrative services, general maintenance, locating suitable funding sources and other fisheries management support services (DMR Annual Report).

Marine Fisheries personnel have been involved with regional management activities of the Gulf States Marine Fisheries Commission (GSMFC), including: Artificial Reef Task Force, Flounder Fishery Task Force, Blue Crab Task Force, Data Management and Recreational Fishery Subcommittee, Technical Coordinating Committee and the State /Federal Fisheries Management Committee. The Marine Fisheries Office was instrumental in preparing grant documents and proposals to secure funding for fisheries management projects: Sport Fish Restoration Act with the U.S. Department of the Interior, and the Cooperative Fishery Statistics Program and the Interjurisdictional Fisheries Act with the U.S. Department of Commerce (DMR Annual Report 2000).

The Marine Fisheries Statistics Department of the DMR is primarily responsible for collecting commercial fisheries landing and catch data for Mississippi in a timely manner, assessing biological data for selected commercially-important finfish species, and obtaining boat trip information and biological statistics on migratory, pelagic, and reef fishes such as red snapper, grouper and amberjack, and collecting otoliths from red snapper (DMR Annual Report).

Another essential division of the Mississippi Department of Marine Resources is the Mississippi Shellfish Management Program. This division, works to maintain program compliance with the Interstate Shellfish Sanitation Conferences' National Shellfish Sanitation Program, mapping of Mississippi's oyster reefs, surveying of potential cultivation sites and cultch planting sites, cultivation of oyster reefs, and deposition of oyster cultch material (DMR Annual Report 2000).

The Shrimp and Crab Management Division deals with the long-term monitoring of shrimp and crab populations in order to make management recommendations, inspection of live-bait shrimp operations and compilation of confidential live-bait dealer reports. Constant recorder instruments along the coast provide real-time hydrological monitoring. The issuance of saltwater scientific collection permits, also falls under their purview. They have also coordinated Sport Fish Restoration Grants with the U.S. Fish and Wildlife Service, the administration of the NOAA Fisheries' Federal Brown Shrimp Disaster Grant, and the Derelict Crab Trap Recycling Program (DMR Annual Report 2000). For additional information on the Mississippi Department of Marine Resources visit the department web site at http://www.dmr.state.ms.us/

3.4.2.1.4 The Alabama Department of Conservation and Natural Resources

The Alabama Marine Resource Division of the ADCNR manages Alabama's marine fisheries resources with assessment and monitoring, applied research, and enforcement programs. There are currently three division offices located on Dauphin Island, Bayou La Batre, and Gulf Shores.

The Administrative Section of this division handles clerical services, general administrative support, purchasing, and supervision for the Enforcement and Fisheries Sections. They oversee seismic studies in state waters and coordinate with other state, Federal, and regional agencies on fisheries issues and environmental concerns. The administrative section is responsible for drafting legislative and regulatory changes required in order to properly manage Alabama's marine resources (Alabama DCNR 2002).

The Fisheries Section is responsible for collecting data, and making recommendations to the Administrative Section concerning management of commercial and recreational fisheries in Alabama waters. The Fisheries Section maintains ongoing biological sampling, data analysis, and basic research programs. The greatest effort is directed toward commercially and recreationally important finfish, shrimp and oyster populations. Section biologists continually monitor and assess, fish, shrimp, and oyster habitat and populations, checking the size and number of organisms (Alabama DCNR 2002).

The Fisheries Section works with inter-agency scientists and members of the oil and gas industries to provide recommendations for the locations of wells, production facilities, and corridors with the goal of minimizing the impact of oil and gas industries on coastal resources (Alabama DCNR 2002).

Monthly sampling of fish, shellfish and water quality parameters are conducted along twenty-eight established coastal bays and waterways. The responsibility for monthly sampling lies with the Southeast Area Monitoring and Assessment Program (SEAMAP). This work contributes to the management of the species sampled, helping to determine which waters should be open or closed to harvest and supporting decisions regarding size and creel limits on fish (Alabama DCNR 2002).

The Division has many ongoing projects including annual diver assisted sampling of public oyster, mortality/survival studies of recreationally important finfish and assessment of age structure in reef fish stocks. The DCNR also has a program that determines the effectiveness of artificial reefs. Personnel inspect and must approve all materials used to create artificial reefs within Alabama's designated areas. The Department collects data pertaining to the types and sizes of fish being harvested through the use of a Recreational Fishing Creel Surveys. Creel survey data is used to conduct stock analyses and make recommendations of size and creel limits. The Division, along with SEAMAP, participates in a region-wide state/Federal monitoring and assessment program to produce data on all fisheries stocks in the Gulf of Mexico and internal state waters. Sampling includes shrimp, groundfish, plankton, and reef fish. In Gulf Shores, the Division operates the Claude Peteet Mariculture Center which encompasses thirty-five saltwater ponds, a laboratory, and closed system culture units. Projects at the facility include perfecting techniques for spawning, rearing, and producing shrimp in brackish water ponds. The Enforcement Section patrols Alabama's coastal waters. The officers enforce laws and regulations pertaining to boating safety, fishing, and hunting; conduct search and rescue missions; and participate in drug interdiction operations

The Division comments on all U.S. Army Corps of Engineers permit applications in Alabama's coastal jurisdiction to ensure protection of Alabama's critical marine and estuarine habitats. The Division also works in conjunction with the U.S. Coast Guard in the planning and implementation of toxic spill responses and other marine emergencies. Division personnel also participate in regular regional meetings in conjunction with the Gulf States Marine Fisheries Commission, and the Gulf of Mexico Fisheries Management Council.

The Division's Head Enforcement Officer represents the division on the Interstate Shellfish Sanitation Conference, which is a cooperative venture with other state fishery agencies, state health departments, and Federal agencies, to manage the resources and protect the public. Personnel also cooperate with other state and Federal agencies locally in programs such as the Mobile Bay National Estuary Program, Weeks Bay National Estuarine Reserve, and the Gulf of Mexico Program. Along with this, the Division educates school children, Elder Hostel Members, and other public groups. The web site for the department is http://www.dcnr.state.al.us/mr/index.html.

3.4.2.1.5 The Florida Fish and Wildlife Conservation Commission

The Florida Fish and Wildlife Conservation Commission (FWC) came into existence on July 1, 1999, the product of a constitutional amendment approved by General Election. The new Commission combined all staff and Commissioners of the former Marine Fisheries Commission, the Game and Freshwater Fish Commission, and elements of the Divisions of Marine Resources and Law Enforcement of the Florida Department of Environmental Protection (FDEP) (Florida Fish and Wildlife Conservation Commission 2002).

Commissioners are appointed by the Governor and confirmed by the Florida Senate to five-year terms. There are currently seven commissioners who are to exercise the "...regulatory and executive powers of the state with respect to marine life, except that all license fees and penalties for violating regulations shall be as provided by law." An executive director serves at the pleasure of the commissioners, and the agency has about 1,800 employees organized in the divisions of wildlife, freshwater fisheries, marine fisheries, law enforcement, administration, Florida Marine Research Institute (FMRI), and the offices of environmental services, and informational services, and executive director, (Florida Fish and Wildlife Conservation Commission 2002).

The Division of Marine Fisheries, with 42 employees (2002), develops proposals for regulatory and management options for marine fishery resources for consideration by the Commissioners. In the Gulf of Mexico, state jurisdiction reaches out three leagues (approximately nine nm) from shore. The Division director serves as a liaison to a number of Federal agencies, such as the Gulf of Mexico and South Atlantic Fishery Management Councils, and the Gulf States and Atlantic States Marine Fisheries Commissions, on marine issues. Major responsibilities of the Division include monitoring of catch quotas of marine fisheries stocks, issuance of seafood dealer and commercial fishing licenses, facilitating artificial reef development and deployment, and educational activities.

The Florida Marine Research Institute (FMRI), based in St. Petersburg, has about 200 career-service employees and a like number of contract scientists and technicians that conduct research and work on a great array of marine issues. The institute collaborates extensively with other academic, non-profit and private research institutions on marine conservation and management issues. Example research efforts conducted by FMRI include: extensive studies of the status of seagrasses in numerous estuaries and Florida Bay; river monitoring to assess the effects of surface water withdrawal in the Tampa Bay area; research and stock enhancement of red drum; monitoring and assessment of red tide occurrences, its potential causes, and impacts on fish and shellfish around the state; visual surveys to estimate relative abundance of economically important fish species in coral reefs in the Florida Keys National Marine Sanctuary; and the well-established Fisheries Independent-Monitoring (FIM) program performs stratified-random sampling in six regions around Florida to estimate fish abundance and population trends. Other projects include restoration of wetland habitats and establishment of donor sites to supply wetland vegetation such as salt-marsh plants, seagrasses, and mangroves, which are all critically important for fish habitats.

The Division of Law Enforcement represents about half of the agency's total personnel, with 880 employees, 703 of whom are sworn officers. The Former Marine Patrol was incorporated into this division when the FWC was formed. The division emphasizes compliance with fishing and hunting regulations, and also enforces state and Federal laws that protect threatened and endangered species, and laws dealing with the commercial trade of wildlife and wildlife products, (Florida Fish and Wildlife Conservation Commission 2002).

The Office of Environmental Services (OES) role is to assist in the maintenance and enhancement of fish and wildlife habitat. By monitoring and commenting on the range of development and associated resource management issues, OES seeks to reduce unnecessary human cultural impacts on Florida's fish and wildlife. With an office of 47 employees, the Bureau of Protected Species managing manatees, sea turtles and other types of listed sea life, is located within the OES (Florida Fish and Wildlife Conservation Commission 2002). The protected species that occur in Florida are the following: manatees, northern right whales, and five sea turtles including the green, leatherback, loggerhead, Kemp's Ridley, and Hawksbill turtles, (Florida Fish and Wildlife Conservation Commission 2002). The web site for the Department is http://www.floridaconservation.org/.

3.4.2.2 State programs for artificial reefs

3.4.2.2.1 Texas

In 1989, the legislature of Texas directed Texas Parks and Wildlife to develop a State Artificial Reef Plan to create and enhance reef fish habitat offshore of Texas (Culbertson *et al*. 2000). However, the Agency had been involved in artificial reef development since the 1940s starting with transplanting oyster spat and developing oyster reefs from 1947-1989, the use of concrete structures and cars in nearshore waters from the 1950s-1970s, and the transfer of five Liberty ships to offshore locations in the 1970s. These ships represented the first successful offshore artificial reef off the coast of Texas.

The goals of the Texas Artificial Reef Plan are to enhance the fishery resources biologically, commercially, and recreationally. The program utilizes a citizen advisory committee to create new sites, evaluate material donations, and minimize user conflicts.

Oil and gas platforms are the primary reef building material of choice, since they already serve as artificial reefs in the Gulf of Mexico and also meet the material criteria. The Artificial Reef Program promotes the use of "partially mechanically removed" structures to minimize damage to the benthic communities attached to the structure, and to minimize loss of reef fish from the use of explosives when toppling structures in place to create artificial reefs. These standing structures allow the maximum biological profile to remain higher in the water column and still meet safe navigational clearances.

3.4.2.2.2 Louisiana

The Louisiana Fishing Enhancement Act was signed into law in 1986, creating the Louisiana Artificial Reef Program (1987, L.A. Artificial Reef Plan, Charles Wilson, Va & Pope). This program was designed to take advantage of fishing opportunities provided by these obsolete platforms. Currently, over 75% of all recreational fishing trips originating in Louisiana are destined for one or more of these structures. Since the program's inception, 34 reef sites (using the jackets of 110 obsolete platforms), have been created off Louisiana's coast. Their large numbers, design, longevity and stability have provided a number of advantages over the use of traditional artificial reef materials. The participating companies save money by converting the structure into a reef rather than dismantling it onshore and are required to donate a portion of the savings to the state to run the state program. One disadvantage, however, is that their large size restricts the distance to shore where these platforms can be sited. To achieve the minimum clearance of 50’ as required by the Coast Guard regulations, the platforms must be placed in waters in excess of 100’. Waters compatible with reef development are generally found between 30 and 70 miles off Louisiana's gently sloping continental shelf, making them accessible to anglers with offshore vessels. Funds generated by the program can be used to develop reefs closer to shore using alternative low profile materials. The reef program has used shell for low profile reefs in shallow water.

3.4.2.2.3 Mississippi

The Mississippi legislature authorized the Department of Marine Resources to promote, construct, monitor and maintain artificial fishing reefs in the marine waters of the State of Mississippi, and in adjacent Federal waters; to accept grants and donations of money or materials from public and private sources for such reefs; and to apply for any Federal permits necessary for the construction or maintenance of artificial fishing reefs in Federal waters (Mississippi 1999).

The earliest known artificial reefs off Mississippi were created when automobile bodies were deployed in offshore waters in the 1960s. Mississippi took advantage in 1972 when derelict World War II Liberty ships were made available for artificial reef creation. In a cooperative effort between the State and the Mississippi Gulf Fishing Banks (MGFB), a local non-profit fishermen’s organization, five Liberty ship hulls were placed on two permitted sites offshore Horn Island. Subsequently, the permits for these two sights were transferred to the MGFB, and they have acquired eight additional permits for artificial reef creation. Mississippi Department of Marine Resources also holds 21 permits for nearshore, low profile artificial reef sites where clam or oyster shell has been placed. These are primarily near fishing piers and bridges (MDMR, 1999).

Combined, there are 2100 acres of permitted artificial reef area off Mississippi's coast. The MGFB is responsible for the maintenance of all the sites. In 1999, the MDMR developed a comprehensive plan for artificial reef development that outlined guiding principles, goals and objectives; guidelines and recommendations to properly site an artificial reef involving environmental/biological criteria and social and economic factors; and suitable (and unsuitable) materials that can be used and reef construction; permitting; description of the four artificial reef development zones; and monitoring.

3.4.2.2.4 Alabama

Alabama's Artificial Reef Program is the product of a cooperative agreement between the U. S. Army Corps of Engineers and the Marine Resources Division of the Alabama Department of Conservation and Natural Resources. In 1953, the DCNR was the first agency in the Nation to establish an artificial reef construction program.

Approximately 3,108 square km (1,200 square miles) of offshore waters are included in the artificial reef general permit areas of Alabama, making this the largest artificial reef program in the U. S. Additionally, Alabama was the first to establish general permit sites in its offshore waters. The five permit areas are set forth inside bold lines on the map and are called the Hugh Swingle General Permit Area, the Don Kelley General Permit Area - North, the Don Kelley General Permit Area - South, the Tatum - Winn General Permit Area - North, and the Tatum - Winn General Permit Area - South. Within these general permit areas, artificial reefs can be constructed by individuals by acquiring a permit from the Marine Resources Division. Offices of the Marine Resources Division are located in Gulf Shores and on Dauphin Island. Both of these offices have individuals trained in artificial reef permitting and can schedule an inspection of reef material in a timely manner. In order for individuals to construct artificial reefs outside of the general permit areas previously mentioned, a permit must be obtained from the U. S. Army Corps of Engineers pursuant to Section 10 of the River and Harbor Act of 1899, Section 404 of the Clean Water Act, and Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972, as amended.

The advantages to utilizing the General Permit Areas for artificial reef construction are numerous; however, the three main advantages are: (A) a permit can be acquired in most instances within one (1) working day after the request is made. (B) While the specific area on which an individuals' artificial reef is confidential, the location is not publicized, and (C) the chances of artificial reefs within the general permit area coming in conflict with the shrimping industry are reduced. However, the less restrictive permitting environment may lead to artificial reefs of varying design and composition, and of unknown utility as marine habitat.

3.4.2.2.5 Florida

The Florida artificial reef program is the only state program in the Gulf of Mexico that is not exclusively run at a state agency level where the state holds all the reef area permits (Dodrill 2000). Because of the extent of coastline and statewide involvement in reef activities, the state program continues as a cooperative partnership started over twenty years ago with local coastal governments. Today some local coastal cities, and most recently, qualified non-profit corporations also work directly with the Florida Fish and Wildlife Conservation Commission (FWC) in artificial reef development and monitoring activities.

Thirty-four of 35 Florida coastal counties spread along 8,426 miles of coastline are or have been involved in artificial reef development. More than 1600 documented public artificial reefs have been placed in state and Federal waters off these counties since 1920. Most of the reef development has taken place in the last 15 years. Local coastal governments hold all but two of the more than 300 active artificial reef permits off both Florida coasts. About half of these sites are in Federal waters. Fishing clubs, non-profit corporations, and interested private individuals work through the local governments as the liable permit holders to provide input into public reef building activity.

Under the program, reefs have been constructed with one or more of the following intended objectives: 1) enhance private recreational and charter fishing and diving opportunities; 2) provide a socioeconomic benefit to local coastal communities; 3) increase reef fish habitat; 4) reduce user conflicts; 5) facilitate reef-related research; and, 6) while accomplishing objectives 1-5, do no harm to fishery resources, EFH, or human health. Other reef-building objectives undertaken in Florida but outside the FWC include mitigation or restoration reefs to replace hard bottom habitat lost through such activities as beach renourishment. Materials deployed are usually “materials of opportunity”, such as concrete rubble, including culverts, junction boxes, slabs, bridges, scarp steel, as well as vessel/barges.

3.4.2.3 Non-fishery specific laws and regulations

States often have their own permitting processes for any activities that may affect wetlands, waters, and other environmentally-sensitive habitats and ecosystems. States have the ability to be more stringent than Federal laws on the same issue. Additionally, states may have their own land/water protection program with defined designations such as aquatic preserve, marine reserve, wildlife refuges, and wild and scenic river, to name a few. Each state sets its own parameters, with regard to the types of activities or development that may occur in these designated areas, and will usually require that proposed activities be reviewed to ensure that they will not cause environmental harm. Some states require that a permit be obtained before the activity can proceed. However, there is no process for the Council or NOAA Fisheries to provide comments or review of state permitting activities to ensure adequate safeguards to protect EFH, unless there are concurrent Federal licenses, permits, or funding required.

3.4.3 Local land use regulations and policies

The manner in which land and waterways are used, maintained, and developed is an important component in promoting and ensuring the integrity of natural resources. Many areas throughout the Gulf of Mexico have experienced, and continue to experience, significant declines in water quality and substantial losses of important wetlands and coastal areas due to growth and development pressures. Much of this loss can be attributed to the failure of local communities to sufficiently plan for growth by ensuring that development occurs in a way that protects important natural resources.

Local land use zoning regulations, ordinances, and growth management policies direct the way land is developed by designating areas suitable for business, residential, and industry, and by establishing appropriate management practices for construction activities. Regulations can also prohibit business development in certain areas, identify unique open space areas that should be protected and remain undeveloped, or require establishment of easements and natural corridors around wetlands or along waterways, in order to protect water quality, and fish and wildlife habitat. Thus land use regulations have a major impact on the quality of environmental resources.

There is little opportunity and no designated process for input from the Council or NOAA Fisheries, on locally sponsored or permitted activities, unless there are concurrent Federal licenses, permits, or funding required.

3.5 Threats to Habitat

3.5.1 Protected areas already established by the Gulf Council

A number of sites have been designated by the Gulf Council as marine protected areas (Figure 3.3.1). Some of these closures are specifically gear closures, which were established to protect stocks by reducing fishing pressure during certain seasons or year round. These closures also have the effect of protecting the habitat from the potential adverse effects of these gears. Others were established specifically to protect habitat. A description of each site, and the major species it is intended to protect, are provided in the following sections. The appropriate closed areas also appear on all fishing effort maps (Figures 3.3.2 – 3.3.11) for those gears which are excluding from use within them.

3.5.1.1 Tortugas Shrimp Sanctuary

A 3,652 nm^2 shrimp nursery ground in the Florida Keys permanently closed by the Shrimp FMP (June 1981) to use of trawls and harvest or possession of shrimp. The sanctuary results in shrimp growing to about 47 count/pound before harvest. The geographical extent of the sanctuary was determined by years of sampling shrimp to determine their size by season by the University of Miami. In most years, when they migrate across the boundary, the shrimp have reached legal size (47 count). The sanctuary has been closed to shrimp trawls for more than 30 years. Therefore, much of the bottom is covered with live bottom organisms (sponges, algae, etc.). Not only is it an important nursery for pink shrimp, but also for larvae of the spiny lobster as they settle out from their planktonic state.

3.5.1.2 Cooperative Texas Shrimp Closure

A 5,475 nm^2 shrimp nursery ground off Texas cooperatively closed under the Shrimp FMP (June 1981) by the Council and state of Texas for 45 to 60 days out to either 15 or 200 miles. The closure results in shrimp growing to about 39 count/pound. While the primary emphasis for the closure is to allow the juvenile shrimp to grow to a larger size before harvest, it also has secondary benefits by preventing some mortality on bycatch species from trawling that would have occurred. To enhance enforceability by aircraft, the closure usually extends 200 miles offshore. The benefits to the shrimping industry of the closure have been documented annually since 1981.

3.5.1.3 Southwest Florida Seasonal Closure (Shrimp/Stone Crab)

A 4,051 nm^2 closure under the Stone Crab FMP (October 1979) of Federal and state waters cooperatively by the Council and the State of Florida to shrimping from November 1 through May 20 inshore of the line to protect juvenile stone crab and prevent loss of stone crab traps in trawls. The area was closed to resolve a gear conflict between stone crab fishermen who fished during daylight and shrimp fishermen who fished at night. According to the shrimp fishermen negotiating the resolution of this conflict, only about 10 percent of the bottoms inshore of the line were trawlable.

3.5.1.4 Central Florida Shrimp/Stone Crab Separation Zones

A 174 nm^2 closure under Stone Crab Amendment 2 (September 1984) of state and Federal waters cooperatively by the Council and the State of Florida to either shrimping or crabbing from October 5 to May 20. Crab or shrimp fishing alternate in zones IV and V. These areas were closed to resolve a gear conflict between stone crab and shrimp fishermen. The areas permanently closed to shrimping (i.e., Zones I and III) probably have enhanced growths of live bottom organisms.

3.5.1.5 Longline/Buoy Gear Area Closure

A 72,300 nm^2 permanent closure implemented by Reef Fish Amendment 1 (February 1990) to use of these gears for reef fish harvest inshore of 20 fathoms off the Florida shelf and inshore of 50 fathoms for the remainder of the Gulf. Closure of the central and western Gulf to longline and buoy gear inshore of 50 fathoms was done to protect the larger red snapper spawning population. The observer study by Prytherch (1983) indicated for the western Gulf that 95% of the red snapper landed and 56% of all the fish landed (by number) from longline vessels were greater than 14 pounds average weight. These larger red snapper were so sparsely distributed that harvest by bandit rigs was usually not productive. Closure of the eastern Gulf to 20 fathoms was largely to reduce the number of undersize (<20 inches TL) grouper hooked, since the predominance of undersize fish was much greater in waters shallower than 20 fathoms. The 20-fathom boundary of the closed area would prohibit longlining in the area most recreational fishermen used, reducing the potential for conflicts.

3.5.1.6 Florida Middle Grounds HAPC

A pristine 348 nm^2 coral area protected by the Coral FMP (August 1984) where use of any fishing gear interfacing with bottom is prohibited. The area consists of the topographical highs in the general area called the Middle Grounds. Although the area has some hard coral, it is predominantly covered with soft coral (gorgonians). It supports a large assemblage of fishes associated with live bottom. Before its designation as a HAPC, shrimp vessels periodically fished some areas of the reef complex. The Coral FMP (Section 3.4.1.2.2.7) named nine areas as coral HAPCs in the Gulf and South Atlantic areas. All but three of these were already under the protective rules of Federal or state agencies. The Flower Garden Banks, Florida Middle Ground, and Oculina Banks were established as HAPCs under FMP rule. Three other areas were considered but not named as HAPCs.

3.5.1.7 Madison/Swanson and Steamboat Lumps Marine Reserves

These are no-take marine reserves established by an August 1999 Reef Fish Regulatory Amendment (May 2000) and sited on gag grouper spawning aggregation areas where all fishing is prohibited (219 snm), except for highly migratory species. The area is described in Moe's (1963) fishing survey as having rock ledges with relief up to 5 fathoms (9 m). There are outcrops of limestone and reef fish habitat (Chris Gledhill, Pascagoula NMFS lab, personal communication), and transects through this area by Ludwick and Walton (1957) showed pinnacle trends. These marine reserves were established for four years, while the closures are evaluated for their effectiveness in enhancing the ecosystem. The prohibition on fishing protects the critical life history stage of spawning for gag grouper and scamp, both of which aggregate to spawn in these areas. When the fish are aggregated they are more easily exploited by fishermen. The gag stock was being subjected to overfishing (i.e., $F>F_{MSY}$), according to NOAA Fisheries.

3.5.1.8 Stressed Area

A 48,400 nm^2 permanent closure, implemented by the Reef Fish FMP (November 1984) from Florida to Louisiana and later Gulf-wide by Amendment 1 (February 1990), of the nearshore waters to use of fish traps, power heads, and roller trawls (i.e., "rock hopper trawls"). Data available and local knowledge of the fishery resulted in defining the geographic boundary of the stressed areas which was characterized by excessive fishing pressure by the recreational sector, resulting in reduced catch, reduced CPUE, and decreased size of certain species, (i.e., subject to growth overfishing). To prohibit new and more efficient gear from exasperating this problem, the Council prohibited the use of fish traps, powerheads, and roller trawls (i.e., rock hopper trawls) within this area. One of the criteria for delineating the stressed area was need for protection of special habitats; therefore, the prohibited areas encompass the Florida coral reef tracts and seagrass beds, natural and artificial reefs off Alabama and Mississippi, and the reefs off the Galveston-Sabine, Texas area. The stressed area was subsequently extended to the Louisiana area and off all of Texas by Reef Fish Amendment 1.

3.5.1.9 Flower Garden Banks HAPC

A pristine coral area protected by the Coral FMP (August 1984) by preventing use of gear interfacing with the bottom. Subsequently made a marine sanctuary by NOS (41 nm^2). This is the most northern hard coral complex in the Gulf and is a unique coral complex with a coral-associated reef fish assemblage.

3.5.1.10 Tortugas North and South Marine Reserves

No-take marine reserves cooperatively implemented (July 2001) by the State of Florida, NOS, the Council, and National Park Service (see jurisdictions on chart) (185 nm^2) will remain closed to fishing for ten years and the closures evaluated for their effectiveness in enhancing the ecosystem. No fishing is allowed in Madison/Swanson or Steamboat Lumps, except for highly migratory species. In the Tortugas North Reserve, no fishing, anchoring or diving is allowed and vessels within the Reserve must be in transit with all fishing gear stowed. In the Tortugas South Reserve, no fishing or anchoring is allowed and diving is limited by the number of mooring buoys available for vessels.

The Tortugas geologic formations are described in Section 3.1.1.3 and a biological description of the corals is presented in Section 3.2.2.1. Riley's Hump is a pinnacle with relatively pristine coral formations and was the last known spawning aggregation site for mutton snapper in the Gulf. All fishing was prohibited in 1994 on Riley's Hump during May and June (peak spawning months for mutton snapper) by Reef Fish Amendment 5. Tortugas North marine reserve is sited on the northeast portion of Tortugas Bank, which was listed in the Coral FMP (August 1984) as a potential HAPC. Both areas are important spawning sites for grouper, especially black, red, gag, Nassau, yellowfin, and the scamp and hinds, which are considered by Ault, *et al*. (1998) to be locally subject to overfishing. Snapper observed as using the areas for spawning included gray, mutton, cubera, yellowtail, and dog.

The following table provides the area (nm^2) protected by each FMP area closure and marine protected area.

Closure Area (see Figure 3.3.1)	**Area (nm^2)**	**Gear Closure**	**Area Closure**	**Seasonal Closure**
Gulf-Wide Closures				
Stressed Area Closure	48,400		[	
Longline/Buoy Gear Closure			[	
Eastern Gulf	24,400			

Closure Area (see Figure 3.3.1)	**Area (nm^2)**	**Gear Closure**	**Area Closure**	**Seasonal Closure**
Central/Western Gulf	47,900			
Total	**72,300**			
Florida Closures				
Tortugas Shrimp Sanctuary	3,652		[	
Southwest Florida Shrimp/Stone Crab Closure				[
State waters	2,562			
Federal waters	1,489			
Central Florida Shrimp/Stone Crab Separation Zones	174			[
Florida Middle Ground HAPC	348		[	
Tortugas South Marine Reserve	60		[	
Madison/Swanson Marine Reserve	115		[	
Steamboat Lumps Marine Reserve	104		[	
Florida Total	**8,594**			
Texas Closures				
Cooperative Shrimp Closure				[
Initial 15 miles offshore	5,475			
200 miles	NA			
Flower Gardens Banks HAPC	41		[	
Texas Total	**5,516**			
Overall Total	**134,720**			

3.5.2 Fishing impacts

3.5.2.1 Fishing gear impacts

As part of an effort to identify fishing impacts on fish habitat from the gears used in the Gulf of Mexico, South Atlantic, and Caribbean Regions, Rester (2000a, b; 2001) compiled an annotated bibliography of papers and reports that addressed fishery-related habitat impacts. The bibliography included scientific literature, technical reports, state and Federal agency reports, college theses, conference and meeting proceedings, popular articles, memoranda, and other forms of nonscientific literature, but did not include studies that pertained to the ecosystem effects of fishing (e.g. changes in the biological community structure). While recognizing that fishing may have many varying impacts on EFH, the bibliography focused on the physical impacts of fishing activities on habitat.

Barnette (2001) used the over 600 papers compiled by Rester (2000a, 2000b, 2001) to examine fishing impacts in the Southeast Region. The following section is largely excerpted from Barnette (2001). Barnette found a paucity of readily available information on the numerous types of gear utilized within the South Atlantic, Gulf of Mexico, and Caribbean. While there have been hundreds of studies published on gear impacts worldwide, the majority of these focus on mobile gear such as dredges and trawls. Furthermore, in addition to the approved gears within the various FMPs, there are many gears utilized within state and territorial waters that also needed to be evaluated because EFH may extend into coastal and estuarine waters. However, there are few, if any, habitat impact studies that have been conducted on many of these gear types.

Johnson (2002) also reviewed literature (through May 2002) dealing with the effects of fishing gears on benthic habitats. The document focused on mobile gears, such as trawls and dredges, which are not typically used in Caribbean fisheries, but also contained some information on traps, pots, longlines, and gill nets.

A December 1999 EFH Workshop attended by NOAA Fisheries scientists and managers, also addressed fishing impacts, and examined which factors made gear impact studies relevant to the Southeast Region (Hamilton 2000). The criteria included whether the specified gear was utilized in the Southeast Region, whether it was utilized in the same manner (similar fisheries), and whether the habitat was similar. This review recognized that in many instances numerous epifaunal and infaunal species are an integral part of benthic habitat. Therefore, studies that document impacts (i.e., reduction in biomass or species diversity) to benthic communities have been included in this section.

Studies of gear types that are not applicable to the Southeast Region such as explosives, cyanide/poisons, and beam trawls are not included in this section. Explosives and cyanide have been prohibited by the various Fishery Management Councils due to the documented habitat damage associated with those methods. The numerous studies conducted on beam trawls are also not discussed here, due to the fact that beam trawls are rarely used within the region. While a study published by ICES (1973) concluded that otter trawls and beam trawls are similar in their action on the seabed and that there is not ample reason for considering possible destructive effects of beam and otter trawls separately, it was felt that there were enough studies that specifically detailed otter trawls to exclude the numerous beam trawl studies. Studies documenting habitat damage resulting from anchoring or interactions with marine vessels (e.g., groundings, propeller scarring) are not considered in this section. Anchors are not considered a type of fishing gear unless their use is directly related to harvesting methods (e.g., clam-kicking, skimmer trawling, etc.), but they are discussed in Section 3.5.3.1.1.4 (vessel use). Based on these criteria, habitat impacts, recovery metrics, and management recommendations were extracted from the studies listed in Rester (2000) and Barnette (2001) and included in this section.

DeAlteris *et al.* (1999) stated that fishery-related impacts to fish habitat need to be compared to natural causes, both in magnitude and frequency of disturbance. Fishing can be adjusted or eliminated to protect particular habitats, whereas natural conditions cannot be controlled. Depending on the intensity and frequency, fishing impacts may well fall within the range of natural perturbations. However, Hall (1999) pointed out that while it is important to appreciate the range of natural variation in disturbance from currents, wind, and waves so that fishing can be put into context, the fact that the natural range is large provides no basis for arguing that the additional perturbation imposed by fishing is inconsequential. Marine communities and their associated habitats have adapted to natural variation. Fishing impacts may introduce a variable that is beyond the range of natural impacts, potentially resulting in dramatic alterations in habitat or species composition. For example, Posey *et al.* (1996) suggested that deeper burrowing fauna are not affected by severe episodic storms, though fishing may still impact them. The study site was at a depth of 13 m and samples were collected to a depth of 15cm below the substrate. "Deeper burrowing" was not defined, but it implies fauna living at a depth of 7 - 15cm (Jennings and Kaiser 1998) which is well within the depths disturbed by trawls and dredges (Krost and Rumohr 1990). Regardless, information from studies that include comparisons of fishery-related impacts to natural events have been included in the scope of this review.

All fishing has an effect on the marine environment, and therefore the associated habitat. Fishing has been identified as the most widespread human exploitative activity in the marine environment (Jennings and Kaiser 1998). Fishing impacts may range from the extraction of a species, which skews community composition and diversity, to reduction of habitat complexity through direct physical impacts of fishing gear. Activities such as repeat trawling of an area may shift the benthic community from large-bodied to small-bodied organisms adapted to frequent disturbance (NRC 2002).

The nature and magnitude of the effects of fishing activities depend heavily upon the physical and biological characteristics of a specific area in question. While there are limitations on the degree to which probable local effects can be inferred from the studies of fishing practices conducted elsewhere (NC Division of Marine Fisheries 1999), the lack of area-specific studies is insufficient justification to postpone management of fishing effects on seafloor habitat (National Research Council 2002). The extreme variability that occurs within marine habitats confounds the ability to easily evaluate habitat impacts on a regional basis. Marine communities that have adapted to highly dynamic environmental conditions (e.g., estuaries) may not be affected as greatly as those communities that are adapted to stable environmental conditions, such as deep water communities (NRC 2002), and biogenic habitats are particularly vulnerable. While recognizing the pitfalls that are associated with applying the results of gear impact studies from other geographical areas, due to the lack of sufficient and specific information within the

Southeast Region it is necessary to review and carefully interpret all available literature in hopes of improving regional knowledge and understanding of fishery-related habitat impacts.

In addition to the environmental variability that occurs within the region, the various types of fishing gear and how each is utilized on various habitat types affect the resulting potential impacts. Additionally, the intensity of fishing activities needs to be considered. Whereas a single incident may have a negligible impact on the marine environment, the cumulative effect may be much more severe.

Within intensively fished grounds, the background levels of natural disturbance may have been exceeded, leading to long-term changes in the local benthic community (Jennings and Kaiser 1998). Collie (1998) suggested that, to a large extent, it is the cumulative impact of bottom fishing, rather than the characteristics of a particular gear, which affects benthic communities. Unfortunately, many fishing-related impact studies do not measure the long-term effects of chronic fishing disturbance. Furthermore, the lack of high-resolution data on the distribution of fishing effort increases the difficulty of estimating the extent of fishing impacts on habitat is (Auster and Langton 1999).

Rates of habitat recovery from gear effects seem to depend on factors like habitat type, the nature of the gear effects, frequency of fishing-related and natural disturbances, and the nature of the associated fauna (NRC 2002). If recovery is allowed, the community may not return to its former equilibrium state, but may go to an alternate stable state.

Fishing gears may also have indirect effects on habitats, such as changes in nutrient cycling (NRC 2002). The effects of fishing can be divided into short-term and long-term impacts. Short-term impacts (e.g., sediment resuspension) are usually directly observable and measurable while long-term impacts (e.g., effects on biodiversity) may be indirect and more difficult to quantify. Even more difficult to assess would be the cascading effects that fishery-related impacts may have on the marine environment.

The majority of existing gear impact studies focus on mobile gear such as trawls and dredges. On a regional scale, mobile gear such as trawls impact more of the benthos than any other gear. However, other fishing practices may have a more significant ecological effect in a particular area due to the nature of the habitat and fishery. Yet there are few studies that investigate other gear types, especially static gear. Rogers *et al*. (1998) stated that there are few accounts of the physical contact of static gear having measurable effects on benthic biota, as the area of seabed affected by each gear is almost insignificant compared to the widespread effects of mobile gear. Regardless, static gear may negatively affect fish habitat and, therefore, must be considered.

The exact relationship that particular impacts have on the associated biological community and productivity is not fully understood. While it is clear that fishing activities impact or alter fish habitat, the result of those impacts or the degree of habitat alteration that still allow for sustainable fishing may be unknown (Dayton *et al*. 1995; Auster *et al*. 1996; Watling and Norse 1998). Hall (1994) noted that not all impacts are negative. A negative effect at one level may sometimes be viewed as a positive effect at a higher level of biological organization – particular species may be removed in small-scale disturbances yet overall community diversity at the regional scale may rise because disturbance allows more species to coexist.

Table 3.5.1 is a cross tabulation of the standard habitat types and all the fishing gears that are potentially used under the FMPs. A ***fishing sensitivity*** is allocated to each combination of habitat type and fishing gear. These relative measures result from modifications of rankings developed during a 1999 NMFS workshop on gear impacts on essential fish habitat in the NOAA Fisheries Southeast Region (Hamilton 2000). The methodology for the development of Table 3.5.1 is presented in Section 2.1.4.2.2.1. This sensitivity table is used for both the spatial analysis of the sensitivity of habitats to different gear types, and in identifying potential HAPC candidate areas in the Gulf.

The most sensitive gear/habitat combinations include fish otter trawls, shrimp otter trawls, roller frame trawls, and pair trawls over coral reefs; crab scrapes over coral reefs; oyster dredges over SAV, oyster reefs, or coral reefs; rakes over coral reefs; and patent tongs over SAV, oyster reefs, or coral reefs. Some of these gear/habitat interactions are unlikely to occur in actual practice. In general, gears that are actively fished by towing have the highest potential to alter habitats. However, some habitats, such as coral reefs and hard bottoms are sensitive to interactions with passive gears (e.g. traps) as well.

One limitation of this analysis concerns the lack of knowledge about the way a fishing gear might affect the same habitat type in different zones (i.e. estuarine, nearshore, and offshore). For instance, would the disturbance of soft bottoms caused by an otter trawl have the same effect on the habitat in an estuary, where natural disturbances are frequent, as it would for offshore soft bottoms, where natural disturbances are less common. While it is generally believed that habitats in relatively stable environments are more sensitive to fishing disturbances than habitats in dynamic environments, there is not sufficient scientific documentation, at present, to make this distinction in the Gulf.

The following sections describe more thoroughly each of the gears that are allowed to be used in the Gulf of Mexico, and what is known about the sensitivity of habitats to those gears.

3.5.2.1.1 Otter trawl

Otter trawls (Figure 3.5.1) pursue invertebrate species such as shrimp and calico scallops and also flounder and butterfish in both state and Federal waters of the Gulf of Mexico. As the most extensively utilized, towed bottom-fishing gear (Watling and Norse 1998), trawls have been identified as the most widespread form of disturbance to marine systems below depths affected by storms (Watling and Norse 1998; Friedlander *et al*. 1999).

For the Gulf shrimp fleet, NOAA Fisheries estimates that about 50% of the vessels in the fishery towed either one 60-foot net or two 30-foot nets (total 60 feet of headrope), while 50% towed four 45-foot nets (total 180 feet of headrope) (1997 NMFS vessel statistics files). Mean spread for eight types of trawls with 60-foot headrope is 75% (range 67%-85%) (Watson, *et al*. 1984), but no data are available for 30- or 45-foot trawls. NOAA Fisheries assumes that 70% spread would be average for all trawls (Pete Sheridan, personal communication).

Impacts

The otter trawl is one of the most studied gear types, thus, there is a wealth of information on its potential impacts to habitat. Jones (1992) broadly classified the way a trawl can affect the seabed as: scraping and ploughing; sediment resuspension; physical habitat destruction, and removal or scattering of non-target benthos. Trawl gear can vary greatly in design, but in general, the various parts of trawl gear that may impact the bottom include the doors, tickler chains, footropes, rollers, and the belly of the net, depending on its operation and towing speeds. Although the passing of one trawl net over a specific bottom site may be relatively minor, the cumulative effect and intensity of trawling may generate long-term changes in benthic communities (Collie *et al*. 1997; NRC 2002).

Trawling has the potential to reduce or degrade structural components and habitat complexity by removing or damaging epifauna; smoothing bedforms (which reduces bottom heterogeneity); and removing structure producing organisms. Trawling may change the distribution and size of sedimentary particles; increase water column turbidity; suppress growth of primary producers; and alter nutrient cycling. The magnitude of trawling disturbance is highly variable. The ecological effect of trawling depends upon site-specific characteristics of the local ecosystem such as bottom type, water depth, community type, gear type, as well as the intensity and duration of trawling and natural disturbances. Trawls used in soft bottoms may remove several centimeters of sediment, and these trawl tracks may still be present more than a year later (Ball *et al*. 2000). Schubel *et al*. (1979) found that the footropes of shrimp trawlers in Texas disturbed approximately the top 50 mm of sediment. Suspended sediment concentrations of 100-500 mg/l were recorded 100 m astern of shrimp trawls in Corpus Christi Bay, Texas (Schubel *et al*. 1979), an estuary dominated by muddy sediments. The same study estimated that the total amount of sediment disturbed annually as a result of shrimp trawling was 25- to 209-million m^3, which is 10 to 100 times greater than the amount dredged during the same period for maintenance of shipping channels in the same area. A study of sediment resuspension mechanisms in Tampa Bay, Florida found that experimental trawling resuspended bottom sediments, and these sediments remained in suspension for as long as 8 hours (Schoellhamer 1996). Schoellhamer (1996) also found that after suspension and resettlement, these sediments were more likely to be resuspended by tidal currents for several hours until bound up by benthic communities and consolidation of clay materials. Additionally, Schoellhamer (1996) concluded that sediment resuspension by anthropogenic disturbances such as trawling and ship wakes were more significant than resuspension by natural wind waves and tidal currents.

A reduction in coverage, loss of rhizomes, sediment suspension, as well as smothering of SAV may occur as a result of otter trawl use (Guillen *et al*. 1994; Ardizzone *et al*. 2000). Reduction of epifaunal coverage, smoothed bedforms, compression of sediments, sediment suspension (fines), and reduction in depth of oxygenated sediments have also been noted to result from the use of otter trawl gear (Thrush *et al*. 1998; Sainsbury *et al*. 1997; Schwinghamer *et al*. 1998). Moreover, when chain gear was used, there was loss or damage to epifaunal coverage within sand bottom areas (Smith *et al*. 1985). Trawling in sand bottoms has been found to displace sediments, while trawl doors may smooth sand waves and penetrate the seabed 0-40 mm (Bridger 1970). When comparing closed areas vs. trawled areas in hard bottoms, there was a reduction in size and density of bryozoan colonies in the trawled areas (Bradstock and Gordon

1983). Trawled areas showed mussel beds of lower structural complexity and less attached epibenthos compared with untrawled areas in hard bottoms (Magorrian 1996). Within muddy sand bottoms otter trawls caused a reduction of epifaunal coverage; smoothed bedforms; compression of sediments; sediment suspension (fines) and a reduction in depth of oxygenated sediments (Thrush *et al*. 1998; Bridger 1970; de Groot 1984).

The component of Gulf shrimp trawls most likely to interact with the benthos and substrates are the tickler chains (J. Watson, personal communication). The purpose of the tickler chain is to disturb the surface of soft sediments and cause shrimp to jump off the bottom and pass over the footrope into the trawl net. In particular, brown and pink shrimp tend to burrow. NOAA gear specialists estimate that 40% of the shrimp that are burrowed are caught in nets that use tickler chains, but no study has been conducted to estimate catch rates without a chain at all (J. Watson, personal communication). Some shrimp trawls are rigged with single chains, while others are rigged with multiple chains in a staggered arrangement about one foot apart ahead of the bottom line of the trawl net. The chain is usually attached to the bottom of the doors, at lengths slightly shorter than the foot rope (normally 36 inches shorter, but can vary; J. Watson, personal communication), and takes a more 'V' shape as it is pulled. The thickness of chains used also varies, but generally, shrimp fishermen use ¼ inch or 5/16 inch chain (less than 1/2 inch) in the Gulf of Mexico (Harrington *et al*. 1988). Heavier chains cause decreased net spread and increased digging in the bottom by the headrope (Harrington *et al*. 1988). Impacts from tickler chains appear to be minor on sand substrates, but are more substantial on live hard bottoms habitats.

Other studies have shown that there are no significant or consistent effects of experimental trawling on any of the soft-sediment organisms studied. One study holds that trawling mimics natural disturbance and stimulates benthic production as if the bottom were cultivated (Cahoon *et al*. No date(a)). It appears that these tracks are relatively temporary in shoal waters and sand sediments, but persist longer in deeper mud areas (DeAlteris *et al*. 1999). Cahoon *et al*. (No date(b)) examined the effects of shrimp and crab trawling on soft bottom habitat in a shallow North Carolina estuary by comparing trawled and untrawled areas. They found "little evidence of direct, negative impacts of trawling activity" on the soft bottom community. Frank *et al*. (in press) compared sediment resuspension in trawled and untrawled zones of a shallow North Carolina estuary and concluded that trawling played a minor role in sediment resuspension compared to natural wind events. Poiner *et al*. (1998) found that a single pass of a prawn trawl in Australia did not significantly alter the benthos, but the cumulative effects of repeat trawling did alter significantly impact the benthos (seven passes removed greater than 50 % of the benthos). Aside from trawling intensity, other factors they found to be important to trawling impacts were the vulnerability of the benthos species to removal and their rates of recovery. Sheridan and Doerr (in press) found that ambient trawling (shrimp otter trawls) had no apparent effect on the sediments or benthos in shallow waters off central Texas.

As elsewhere, the magnitude of trawling disturbance in the Gulf of Mexico is likely to be highly variable, particularly since shrimp fishing effort is variable by area (Figure 3.3.8). Shrimp trawls generally are of much lighter construction than the fish trawls studied in other areas, and are designed to minimize the drag caused from interface with the bottom.

There are no studies that quantitatively compare trawling impacts in the Gulf of Mexico to the natural continuous deposition and resuspension of the sediments, particularly from storm events and the influence of large river flows such as the Mississippi. Therefore, the full impacts of shrimp trawling in the Gulf of Mexico are unknown. However, the National Research Council (2002) recently noted that lack of area-specific studies on the effect of trawling (and dredging gear) is insufficient justifications to postpone management of fishing efforts on seafloor habitat.

Pitcher *et al.* (2000) noted that there is not a direct relationship between the overall amount of trawling effort and the extent of subsequent impacts or the amount of fauna removed because trawling is aggregated and most effort occurs over seabed that has been trawled previously. Yet, several studies indicate that trawls have the potential to seriously impact sensitive habitat areas such as SAV, hard bottom, and coral reefs (Moore and Bullis 1960; Wenner 1983; Guillen *et al.* 1994; Eleuterius 1987; Gomez et al. 1987; Ardizzone *et al.* 2000). In regard to hard bottom and coral reefs, it should be recognized that trawlers do not typically operate in these areas due to the potential damage their gear may incur. While trawl nets have been documented to impact coral reefs, typically resulting in lost gear (Bohnsack, personal observation), these incidents are usually accidental. However, a single experimental trawl tow made accidentally over an unmapped Gulf of Mexico coral reef in 420-361 m of water contained over 300 pounds of coral (Moore and Bullis 1960). Partially in response to accusations of trawl activity on hard bottom habitat, a recent research effort to investigate potential impacts on the Florida Middle Ground Habitat Area of Particular Concern concluded that there was no evidence of trawl impacts or other significant fishery-related impacts to the bottom (Mallinson unpublished report).

Low-profile, patchy hard bottom or sponge habitat areas are more likely impacted from trawls due to the gear's ability to work over these habitat types without damaging the gear. In general, trawling in areas with any rigid vertical structure causes a loss of habitat complexity (Auster *et al.* 1996; NRC 2002), and this loss may lead to a shift toward epibenthic species that prefer open bottom (Sainsbury 1988; Sainsbury *et al.* 1994). While it may be concluded that trawls have a minor overall physical impact when employed on sandy and muddy substrates, the available information does not provide sufficient detail to determine the overall or long-term effect of trawling on regional ecosystems.

3.5.2.1.2 Pair trawl

A pair trawl is similar to an otter trawl without doors (i.e. otter boards). The pair trawl is so-named because it is fished using two boats. Each side of the net is attached to one of the vessels, which stay a fixed distance apart while hauling the trawl, thus keeping the net mouth open, and eliminating the need for trawl doors. The pair trawl can be used to harvest either pelagic or demersal fishery species.

<u>Impacts</u>
In situations where the pair trawl is fished at the surface for pelagic species, it does not come near the bottom, and should have no impact on benthic habitats. However, when it is used to fish for demersal species, it does contact the bottom. While its detrimental effects are probably less

than an otter trawl because it lacks doors, it still has tickler chains and lines which might damage any habitats with vertical structure (e.g. cutting off sponges at their bases).

3.5.2.1.3 Roller frame trawls

Frame trawls (Figure 3.5.2) are primarily utilized to harvest bait shrimp in the State of Florida. They consist of a frame that holds open a net and supports slotted rollers that turn freely as the trawl moves across the bottom. This motion prevents the scouring and scraping impacts primarily associated with otter trawls. Participants in the fishery usually operate in shallow water, 9.14m (30ft) or less.

<u>Impacts</u>
Futch and Beaumariage (1965) found that while frame trawls gathered large amounts of unattached algae and deciduous *Thalassia testudinium* leaves, no SAV with roots attached were found in the trawl catch. Trawls with larger rollers (20.3cm; 8 in diameter) reduced the amount of bycatch material, with most drags collecting little or no SAV or algae. Additionally, there was minimal SAV degradation; those that did result, however, were mostly from propeller scars (Futch and Beaumariage 1965; Meyer *et al*. 1999). When rake teeth were extended below the rollers, they had a tendency to uproot SAV. Meyer *et al*. (1991) found that while side frame trawls in *Thalassia* beds collected drift algae and deciduous leaves, they did not decrease seagrass shoot density, blade density, blade length, or below-ground biomass. Several studies concluded that frame trawling does not denude vegetated areas permanently or damage the ecology of such locations (Woodburn *et al*. 1957; Tabb 1958; Tabb and Kenny 1967). However, these studies did not evaluate the effects of repetitive trawling.

In contrast to studies that assessed impacts to SAV, Tilmant (1979) found a high incidence of damage to stony corals in a study that investigated frame trawl impacts on hard bottom habitat in Biscayne Bay. Frame trawls turned over or crushed 80% of *Porites porites* and *Solenastrea hyades* and damaged over 50% of sponges and 38% of gorgonians in the trawl path. Macro algae, including *Halimeda* and *Sargassum*, were impacted. *Sargassum* torn loose from the bottom resulted in an early release to the free-floating state. Tilmant (1979) found it doubtful that this action was harmful to *Sargassum* unless it occurred during early column formation. Within dense SAV communities, removal of epibenthic algae, tunicates, sponges, and other primary producers may also be significant. According to Berkeley *et al.* (1985), damage or loss of sponge and coral cover was also a result of roller trawling in hard bottoms. In trawled areas, Tilmant (1979) also noted that in hard bottoms a 30-80% damage to coral was recorded as well as a decline in groups of large and small benthos.

3.5.2.1.4 Skimmer trawl

Skimmer trawls are positioned along the side of a boat, one on each side, and pushed through the water to harvest shrimp. Skimmer trawls (Figure 3.5.3) are supported by a tubular metal frame that skims over the bottom on a weighted metal shoe or skid. Tickler chains are also utilized along the base of the net.

Impacts

Skimmer trawls work on mud bottoms in water generally 3.05 m (10ft) or less. The weighted shoe and tickler chains impact the bottom, resulting in sediment resuspension. Skimmer trawls may cause bottom damage due to improperly tuned or poorly designed gear (skids and bullets) or prop damage in shallow areas (Steele 1994). Furthermore, because skimmer trawls are used in shallow water, they may have a detrimental impact on critical nursery areas such as the marsh/water interface, SAV, or other sensitive submerged habitats. Habitat such as sponges and SAV are cut off by tickler chains and lead lines, as opposed to otter trawl doors which can dig in and tear up the bottom. However, skimmer trawls are expected to impact the bottom less than or the same as otter trawls due to the absence of doors (Nelson 1993; Steele 1993; Kennedy, Jr. 1993; Coale *et al*. 1994).

3.5.2.1.5 Butterfly net

Butterfly nets, also known as wing nets, use a rigid frame, rather than trawl doors (otter boards) to keep the trawl's mouth open. They are fished along the vessel's side attached to an outrigger or hinged to the bow, and usually used to capture shrimp in shallow water at night, when they are near the surface. These nets can also be mounted to stationary structures like docks, to fish the currents of a waterway.

Impact

Since butterfly nets fish the surface waters, and do not contact the bottom, their impact on benthic habitat should be negligible.

3.5.2.1.6 Bottom longline and buoy gear

Bottom longlines use baited hooks on offshoots (gangions or leaders) of a single main line to catch fish at various levels depending on the targeted species. The line can be anchored at the bottom (Figure 3.5.4) in areas too rough for trawling or to target reef-associated species, or set adrift, suspended by floats to target swordfish and sharks. Longlines are widely utilized in numerous fisheries throughout the Southeast Region.

NMFS (1995) used observer data to characterize bottom longline gear use in the eastern Gulf of Mexico as follows. Mainline material was composed of cable or monofilament, with the test strength of the mainline ranging from 900 to 2,000 pounds. The average test was 1,281. The amount of mainline set at a location varied from 0.9 to 9.0 nm, with 2.4 nm the average. Gangion material was monofilament with length ranging from 0.46 to 1.92 m, and an average of 0.79 m. Barbed circle hooks were used for all sets, with both offset and straight hooks being used. Hooks averaged 2.2 inches in shaft length and 0.9 inches from the point to the shaft.

The average number of hooks set at a location was 731.9 (± 378.0 s.d.), varying from 75 to 2100 hooks. The average depth for the 311 sets was 26.6 m (± 14.9 s.d.), with a range of 10 to 70 m. The sets targeting red grouper averaged 18.6 m. Fishing time varied from 0.3 to 24.7 hours with

3.0 hours the average (± 2.7 s.d.). The majority of fishing occurred during daylight hours; however, lines were set at all hours. The majority of the sets occurred over rock bottom (41%), with shell (21%), coral (21%), unknown (14%), pot hole depression (3%), and mud (<1%) comprising the remaining.

From the NOAA Fisheries Logbook data (1990-2001), vessels using bottom longline gear to catch reef fish averaged 25.46 sets of 7.81 miles of longline per trip. Total time for gear in the water averaged 60.64 hours. Vessels using bottom longline gear to predominantly catch sharks averaged 15.56 sets of 9.32 miles of longline per trip, and the gear was in the water an average of 42.86 hours.

Impacts

The principal components of the bottom longline that can produce seabed effects are the anchors or weights, hooks, and the mainline (ICES 2000). When a vessel is retrieving a bottom longline it may be dragged across the bottom for some distance. The substrate penetration, if there were any, would not be expected to exceed the breadth of the fishhook, which is rarely more than 50/mm (Drew and Larsen 1994). Based on these observations, it is logical to assume that longline gear would have a minor impact to sandy or muddy habitat areas. More important is the potential effect of the bottom longline itself, especially when the gear is employed in the vicinity of complex vertical habitat such as sponges, gorgonians, and corals. Observations of halibut longline gear off Alaska included in a North Pacific Fishery Management Council Environmental Impact Statement (NPFMC 1992) provide some insight into the potential interactions longline gear may have with the benthos. During the retrieval process of longline gear, the line was noted to sweep the bottom for considerable distances before lifting off the bottom. It snagged on whatever objects were in its path, including rocks and corals. Smaller rocks were upended and hard corals were broken, though soft corals appeared unaffected by the passing line. Invertebrates and other lightweight objects were dislodged and passed over or under the line. Fish were observed to move the groundline numerous feet along the bottom and up into the water column during escape runs, disturbing objects in their path. This line motion has been noted for distances of 15.2m (50 ft) or more on either side of the hooked fish. Longline gear in the Gulf of Mexico is substantially lighter (often with monofilament groundlines) than the halibut longline gear (generally 5/16th inch nylon or polyester rope as groundline) in Alaska described by Barnette (2001), so Gulf of Mexico longlines should cause less damage than Alaskan longlines. The Alaskan marine ecosystem is much different from that in the GOM, so specific damage assessment in Alaska may not apply to the GOM. Due to the vertical relief that hard bottom and coral reef habitats provide, it would be expected that longline gear may become entangled, resulting in potential impacts to habitat.

Lost or abandoned longline gear potentially causes two problems in addition to those discussed by Barnette (2001): ghost fishing and grappling to retrieve gear. Fishermen generally maintain as much control as practicable over the gear to prevent losses. However, gear sometimes becomes lost because of weather or accidents, and may be abandoned by fishermen in closed areas trying to avoid detection by enforcement. Longline gear continues to catch fish and possibly catches sea turtles if bait or fish parts remain on the hooks, and self-baits if captured fish subsequently attract and catch other fish. The gear stops fishing when all hooks are bare. Cumulative effects of lost longline gear could be significant. Retrieval of lost or abandoned gear typically occurs by dragging a grappling hook across the bottom to snag the line. Grappling would cause minimal habitat damage to soft or unstructured bottom, but could cause severe local damage to fragile habitat such as coral. The magnitude of the potential problems from lost gear has not been evaluated in the Gulf of Mexico.

3.5.2.1.7 Pelagic longlines

Pelagic longline gear is composed of several parts. The primary fishing line, or mainline of the longline system, can vary from five to 40 miles in length, with approximately 20 to 30 hooks per mile. The depth of the mainline is determined by ocean currents and the length of the floatline, which connects the mainline to several buoys and periodic markers with radar reflectors and radio beacons. Each individual hook is connected by a leader to the mainline. Secondary hook and line gear is permitted onboard pelagic longline vessels. Many pelagic longliners troll regular rod and reel gear while drifting to determine what species are available in the area they are passing through. Pelagic longline gear has a negligible impact on benthic EFH, because there is no interaction with bottom habitats.

3.5.2.1.8 Trap/pots

Traps (Figure 3.5.5) and pots (Figure 3.5.6.) are rigid devices, often designed specifically for one species, used to entrap finfish or invertebrates. Generally baited and equipped with one or more funnel openings, they are left unattended for some time before retrieval. Traps and pots are weighted to rest on the bottom, marked with buoys at the surface, and are sometimes attached to numerous other traps via one long line, called a trot line. Traps and pots are widely used on a variety of habitats in both state and Federal waters to harvest species such as lobster, blue crabs, golden crabs, stone crabs, black sea bass, snapper, and grouper. The amount of damage currently done by traps in the Gulf of Mexico is not known, although they are currently prohibited in several areas of the Gulf of Mexico.

Fish Traps

NMFS (1995) used observer data to characterize fish trap usage in the eastern Gulf of Mexico as follows. Fish trap dimensions ranged from 1.5 x 2.2 x 3.2 feet (10.6 cubic feet) to 4 x 2 x 2 feet (16 cubic feet) with 3.5 x 2 x 2 feet (14 cubic feet) being the most common. The trap mesh was made of plastic-coated wire, with meshes of 1.0 x 1.0 inch, 1.5 x 1.5 inch, or 1 x 2 inch, with the latter being used most commonly. Traps made of 1.0 x 1.0 inch mesh, had larger mesh in the trap doors. All traps had biodegradable blow-out panels and escape windows.

Number of trap sets at a location range from six to 37 with an average of 20.6 sets. Traps were set in depths ranging from 18 to 41.5 m with a mean depth of 31.3 meters. Average soak time varied from 0.8 to 88.9 hours with a mean of 10.0 hours. Most traps were set, tended, and retrieved during the daylight, from 0732 to 2120 hours. Traps were set in shell bottom (47%), rock (19%), sponge (16%), sand (14%), unknown (3%), and mud (1%). In sand/shell mixtures only the dominant material was recorded. The majority of trap sets in the eastern Gulf of Mexico were made off the southwest coast of Florida.

From the NMFS Reef fish logbook data, an average of 69 traps were hauled per trip (NUMGEAR), but the number of hauls averaged 236.77 (EFFORT; traps are hauled more than once per trip. Trips averaged 4.53 days (AWAY).

Fish traps will be banned in Federal waters by 2007.

Stone crab and lobster traps

Both stone crab and lobster traps may be constructed of wood or plastic. Stone crab trap are about 12-13 inches in height with length x width dimensions of 16x16 inches, 15 x 21 inches, 15 x 18 inches, or 14 x 14 inches and weights ranging from 50-70 pounds. Soak times for stone crab traps range from nine days to three weeks (Karl Lessard, personal communication).

Lobster traps are about 15-17 inches in height with length x width dimensions of 32 x 22inches or 32 x 24 inches and weights ranging from 60-80 pounds. Soak times range from three to ten days, with average times increasing as the season progresses (Karl Lessard, personal communication). In the Florida Keys, most traps are singles, but when multiple traps are fished they must have a buoy at both ends.

<u>Impacts</u>

Due to their use to harvest species associated with coral and hard bottom habitat, traps and pots may impact and degrade habitat[55]. More studies have been conducted on the impacts of traps on corals than on hard bottom, or other bottom types. Gomez *et al*. (1987) noted the incidental breakage of corals on which traps may fall or settle constitute the destructive effects of this gear. Van der Knapp (1993) noted that fish traps set on staghorn coral easily damaged the coral. The greatest impact is caused when the trap's frame hits the coral formation directly. It appeared that in all observed cases of injury due to traps, the staghorn coral regenerated completely, although the time for regeneration varied from branch to branch. In general, when hard coral is impacted or injured, algae growth can prevent regeneration in the damaged portion of the coral. Damaged gorgonians have been reported to recover completely within a month (Van der Knapp 1993).

Hunt and Matthews (1999) evaluated the potential damage that lobster and stone crab traps can cause in waters around Florida. Traps can reduce the abundance of gorgonian colonies from rope entanglement. Seagrass smothering occurs from trap placement on SAV beds, resulting in SAV "halos," although this appears to be a problem primarily with lost "ghost traps," as Uhrin *et al*. (2002) found that seagrasses recovered when lobster traps were deployed in grassbeds less than six weeks.

In a recent study, Appeldoorn *et al*. (2000) commented that traps may physically damage live organisms, such as corals, gorgonians, and sponges, which provide structure and in some cases, nutrition for reef fish and invertebrates. Damage may include flattening of habitats, particularly by breaking branching corals and gorgonians; injury may lead to reduced growth rates or death,

[55] Pots and traps may also cause ghost fishing. Biodegradable panels or fastenings prevent ghost fishing, but only after the biodegradable portions deteriorates and the pot or trap opens. Length of time for deterioration has not been studied in the Gulf of Mexico.

either directly or through subsequent algal overgrowth or disease infection. During initial hauling, a trap may be dragged over more substrate until it lifts off the bottom. Traps set in trotlines can cause further damage from the trotline being dragged across the bottom, potentially shearing off at their base those organisms most important in providing topographic complexity. Traps that are lost or set unbuoyed are often recovered by dragging a grappling hook across the bottom. This practice can result in dragging induced damage from all components (grappling hook, trap, trotline). The area swept by trotlines upon trap recovery is orders of magnitude greater than the cumulative area of the traps themselves. Appeldoorn *et al*. (2000) documented that single-buoyed fish traps off La Parguera, Puerto Rico, have an impact footprint of approximately 1/m^2 on hard bottom or reef. Trap hauling resulted in 30% of the traps inflicting additional damage to the substrate.

Eno *et al*. (1996) found pots that landed on, or were hauled through beds of bryozoans caused physical damage to the brittle colonies. It was noted that several species of sea pens bent in response to the pressure wave created by a descending pot and lay flat on the seabed, but many were able to reestablish themselves in the sediment. A species of sea fan also was found to be flexible and specimens were not severely damaged when pots were hauled over them. Enos (2001) observed effects of pots (creels and three types of crustacean pots) set in water depths ranging from about 14-23 m, over a wide range of sediment types in Great Britain: mud communities with sea pens, limestone slabs covered by sediment, large boulders interspersed with coarse sediment, and rock. Observation demonstrated that sea pens were able to recover fully from pot impact (left in place for 24-48 hours) within 72-144 hours of the pots being removed. Pots remained static on the seafloor, except in cases where insufficient line and large swells caused pots to bounce off the bottom. When pots were hauled back along the bottom, a track was left in the sediments, but abundances of organisms within that track were not affected. This suggests that in some instances the direct contact of certain gears may not be the primary cause of mortality, rather the frequency and intensity may be more important. This suggests that in some instances the direct contact of certain gears may not be the primary cause of mortality, rather the frequency and intensity may be more important.

Sutherland *et al*. (1983) cited little apparent damage to reef habitats inflicted from fish traps off Florida. The study found four derelict traps sitting atop high profile reefs with four other traps observed within a live-bottom area. There was no visual evidence that traps on the high profile reef killed or injured corals or sponges. One uprooted gorgonian was observed atop a ghost trap in a live-bottom area. However, these observations were made on randomly located derelict traps. Thus, the primary impacts that may occur during deployment and recovery could not be evaluated.

Although each individual trap has a relatively small footprint, the damage can be substantial due to the shear number of traps deployed, including lost and abandoned traps. Traps are not placed randomly; rather they are fished in specific areas multiple times before fishing activity moves to other grounds. Therefore, trap damage will be concentrated (cumulative effect) in particular areas rather than be uniform over all coral reef habitats.

The Florida Division of Marine Resources estimated (Matthews 1999) that at least 100,000 “ghost” traps lay in state and Federal waters in the Florida Keys in non-disaster years, and a single 1998 storm in the Keys caused 111,000 lobster and stone crab traps to be lost. There are not clear estimates of how many of these were recovered.

3.5.2.1.9 Vertical gear

Hook and line, handline, bandit gear, and rod and reel are widely utilized by commercial and recreational fishermen over a variety of estuarine, nearshore, and marine habitats. Hook and line may be employed over reef habitat or trolled in pursuit of pelagic species in both state and Federal waters. Vertical gear fishers rely on finding concentrations of fish within the range of attraction of the few hooks on vertical gear. Concentrations of many managed fish species are higher on hard bottom areas than on sand or mud bottoms. The total amount of damage currently done by vertical gear in the Gulf of Mexico is not known.

Impacts

Historically, little scientific information has existed on the physical impacts on marine habitats from these gear types. Impacts may include entanglement and minor degradation of benthic species from line abrasion and the use of weights (sinkers). Schleyer and Tomalin (2000) noted that discarded or lost fishing line appeared to entangle readily on branching and digitate corals and was accompanied by progressive algal growth. This subsequent fouling eventually overgrows and kills the coral, becoming an amorphous lump once accreted by coralline algae (Schleyer and Tomalin 2000). Lines entangled amongst fragile coral may break delicate gorgonians and similar species.

A recent study has been conducted Chiappone *et al*. (2002) to document the abundance and impacts of remnant commercial and recreational fishing gear on reef biota in the Florida Keys National Marine Sanctuary. Forty-five sites were surveyed in the summer of 2000, covering approximately 8,040 m^2. Almost 90% of the 110 debris items found consisted of monofilament line (38%), wood from lobster pots (20%), combined fishing weights, leaders, and hooks (16%), and rope from lobster traps (13%). Documented impacts associated with the 110 debris items were reported as 54 (49%) causing tissue abrasion, other damage, and/or mortality to 161 individuals or colonies of sessile invertebrates (sponges, branching gorgonians, fire coral, scleractinian corals, and the colonial zoanthid *Palythoa mammilosa.*

More attention has been given to the issue of entanglement of threatened and endangered marine mammals, turtles, and birds by discarded or lost fishing line. During a 2000 Florida Coastal Cleanup, it was reported (http://www.floridacoastalcleanup.org/) that 46 animals were found entangled in marine debris, including 16 by fishing line, and six by fishing nets/rope. Shaver and Plotkin (1998) documented that between 1983 and 1995, the death of three of 473 sea turtles found stranded along the south Texas coast were attributed to large fishing hooks (2) and monofiliment line (1).

Due to the widespread use of weights over coral reef or hard bottom habitat and the concentration of effort over these habitat areas from recreational and commercial fishermen, the cumulative effect resulting from the use of these gear types may lead to significant impacts. Overall, this is an area that requires additional scientific investigation to better understand the relative impacts remnant fishing gear has on EFH.

Anchoring practices by vertical gear vessels potentially causes a problem on reefs or hard bottoms. If vertical gear fishermen anchor up-tide of a spot holding or expected to hold fish, the anchor set could occur on a reef or hard bottom. The fishermen do not retrieve the anchor between sets. Some fishermen use buoys to pull the anchor directly up. This involves letting the buoy slide down the anchor line as the boat proceeds toward the anchor point. After the boat passes the anchor point, the buoy floats the anchor to the surface. Fishermen not employing a float typically steam ahead, the anchor normally pops out of the sediment, and flies in mid water above the bottom because the anchor flukes act as a hydrofoil or wing. The magnitude of the potential problems from anchoring practices has not been evaluated in the Gulf of Mexico. Impacts from anchoring and other vessel operations are discussed more fully in Section 3.5.3.1.1.4, Vessel Use.

3.5.2.1.10 Gill nets & trammel nets

Gillnets (Figure 3.5.12) consist of a wall of netting set in a straight line, equipped with weights at the bottom and floats at the top, and is usually anchored at each end. As fish swim through the virtually invisible monofilament netting, they become entangled when their gills are caught in the mesh, hence the name. Gillnets may be fixed to the bottom (sink net) or set midwater or near the surface to fish for pelagic species. A trammel net (Figure 3.5.13) is made up of two or more panels suspended from a float line and attached to a single lead line. The outer panel(s) is of a larger mesh size than the inner panel. Fish swim through the outer panel and hit the inner panel carrying it through the other outer panel, creating a bag and trapping the fish.

Under the Coastal Migratory Pelagic FMP, run-around gillnets can only be used by special permit endorsements for fishing for king mackerel in Monroe County, and a permit moratorium is in place through October 2005. Currently, there are 16 of these endorsements, and they are only transferable to family members.

These gillnets are approximately 600 yards in length, are fished to just reach the bottom, and vessels usually set just once or twice a day. Due to a low TAC (526,000 lbs.) and boat trip limit (25,000 lbs.), the fishing season for gillnetters does not last much more than one to two weeks (G. DiDomenico, personal communication).

Impacts

The majority of the studies that have investigated impacts of fixed gillnets have determined that they have a minimal effect on the benthos (Carr 1988; ICES 1991; West *et al*. 1994; ICES 1995; Kaiser *et al*. 1996; ASMFC 2000; Stephan *et al*. 2000). However, Carr (1988) noted that ghost gillnets in the Gulf of Maine could become entangled in rough bottom. Williamson (1998) noted that gillnets can snag and break benthic structures. Gomez *et al*. (1987) noted that gill nets set near reefs occasionally result in accidental snarling often resulting in damage to coral. Bottom set gillnets have led to habitat destruction in different regions (Jennings and Polunin 1996). Bottom gillnets set over coral may cause negative impacts as the weighted lines at the base of the net often become entangled with branching and foliaceous corals. As the nets are retrieved, the corals are broken (Breen 1990; Öhman *et al*. 1993; Jennings and Polunin 1996; Kaiser *et al*. 1996; ICES 1999; ICES 2000).

Aside from the potential impacts cited on coral reef communities, the available studies indicate that habitat degradation from gillnets is minor. Several studies note that lost gillnets are quickly colonized by marine species (Carr *et al*. 1985; Cooper *et al*. 1988; Erzini *et al*. 1997; ICES 2000). Some netting would contact reef habitat, becoming heavily overgrown and eventually blended into the background. Erzini *et al*. (1997) noted that the nets eventually became incorporated into the reefs, acting as a base for many colonizing plants and animals. The colonized nets then provided a complex habitat that was attractive to many organisms and may provide a safe haven from predators. Johnson (1990) and Gerrodette *et al*. (1987) noted that as gillnets tend to collapse and "roll up" relatively quickly, they may form a substrate for marine growths and thereby attract fish and other predators which may get entangled. Therefore, gillnets may be more of a ghost fishing problem and entanglement hazard to marine life than as an impact to habitat.

3.5.2.1.11 Purse seine (and Lampara net)

Purse seines (Figures 3.5.14 and 3.5.15) are walls of netting used to encircle entire schools of fish at or near the surface. Spotter planes are often used to locate the schools, which are subsequently surrounded by the netting and trapped by the use of a pursing or drawstring cable threaded through the bottom of the net. When the cable has pulled the netting tight, enclosing the fish in the net, the net is retrieved to congregate the fish. The catch is then either pumped onboard or hauled onboard with a crane-operated dip net in a process called brailing. Purse seines are utilized to harvest menhaden in the Gulf and South Atlantic. Similarly, the lampara net has a large central bunt, or bagging portion, and short wings. The buoyed float line is longer than the weighted lead line so that as the lines are hauled the wings of the net come together at the bottom first, trapping the fish. As the net is brought in, the school of fish is worked into the bunt and captured. In the Florida Keys a modified lampara net is used to harvest baitfish near the top of the water column. The wing is used to skim the water surface as the net is drawn in and fish are herded into the pursing section to be harvested with a dip net.

Impacts

Purse seines in the Gulf menhaden fishery frequently interact with the bottom, resulting in sediment resuspension. Schoellhammer (1996) estimated that resuspended sediments such as those that might arise from the use of purse seining activities would last only a period of hours. Other than this, impacts caused by purse seining are believed to be minimal (Stephan *et al.* 2000).

3.5.2.1.12 Seines

Seines are active fishing gears consisting of a long fence-like wall of netting, with floats along the top of the net and a series of evenly-spaced weights along the bottom of the net, called a leadline. The wall of netting composing the seine, is meant to stretch from the surface of the water to the bottom. Beach seines are deployed off the shoreline in a semicircle to trap fish between the shore and the net, the net is then pulled in, and landed on the beach or shoreline. Haul seines are used away from shore to encircle fish, which are then worked into a smaller pocket until the net can be lifted into the boat for culling. They are both used in state waters.

Impacts

Sadzinski *et al*. (1996) found that seining had no detectable effects on brackish SAV (*Vallisneria* and *Hydrilla*) plant density, height, or species composition in Chesapeake Bay, but did they not assess possible damage to SAV reproductive structures (e.g. – flower shearing). There is a possibility of damage to SAV sites where seines are hauled repeatedly over the same spots over long periods of time (Barnette 2001). Barnette also states that since seines are generally set in flat benthic areas, to avoid net snags and damage, their impact on habitat impact is expected to be minor and temporary.

3.5.2.1.13 Other nets

3.5.2.1.13.1 Push net

A push net consists of a pole attached to a triangular or rectangular frame which supports a mesh net. The fisher uses the pole to push the net across the bottom, usually through seagrass to capture shrimp.

Impacts

DeSylva (1954) determined that push nets have no detrimental effect on habitat.

3.5.2.1.13.2 Cast net

Cast nets are circular nets with a weighted skirt, which are thrown from land or boats over schooling fish. When thrown properly, cast nets spread out and land on the water flat and circular. The weighted perimeter of the net then sinks to the bottom, trapping the fish or invertebrates within. The cast net also has a series of “brail lines” running from the net’s perimeter and up through a large eyelet in the center of the net, where they all meet and connect to a single hand line. Once the cast net has been thrown and sunk, the brail lines can be pulled through the eyelet, causing the bottom of the net to be effectively pursed, so the fish can be landed. These nets are usually used in estuaries and nearshore areas to catch baitfish, mullet, and shrimp.

Impacts

Cast nets can become entangled on encrusted or jagged bottoms with vertically-oriented organisms like sponges, which can be damaged or dislodged in the net retrieval process (Barnette, personal observation; Rydene, personal observation). DeSylva (1954) however found that cast nets had no detrimental effect on habitat.

3.5.2.1.13.3 Drop net

Drop nets are closed-bottom square or circular nets having a square or circular frame attached to the open top of the net. A series of lines run from points on the frame to a single hand line. This allows the net to be lowered into the water to sit flat on the bottom. Bait can be attached to the bottom of the net or dropped onto the water's surface above the net to attract the target species. When the desired species is on or above the net, it is hauled up quickly, presumably capturing the organism. The drop net is also known by the name "lift net", which seems more appropriate. These nets are generally fished in calmer waters with relatively flat sand or mud bottoms in estuarine settings, and are used mostly to catch crabs.

Impacts

Because these nets are fished primarily on sand or mud bottoms (where there is nothing to snag on), and lay flat on the bottom before being pulled straight up, their impact on the habitat should be minimal.

3.5.2.1.13.4 Hoop net

The hoop net is a stationary gear fished horizontally on the bottom. It is constructed of a cone-shaped or flat net, which may or may not have a series of hoops or throats at intervals along its length to hold the net open. The hoops may be made of wood, fiberglass, or metal. The net is secured to the bottom with weights or stakes, and the cod end of the net is usually baited. Fish or invertebrates attracted to the bait, enter the net mouth and move down the conical net, eventually becoming trapped in the cod end. After an adequate soak time, the net is raised at the cod end and the captured organisms removed.

Impacts

Barnette (2001) states that while there are no studies on the habitat impacts of hoop nets, they are probably less detrimental than traps because they are used primarily on flat bottoms.

3.5.2.1.13.5 Pound net

Pound nets consist of a long "fence of netting which causes fish swimming along it, to be directed into an enclosure called a pound, pocket, or heart, from which they cannot escape. The fence of net is oriented perpendicular to the shore. Pound nets are sometimes left in place for a number of years, and are fished exclusively in state waters.

Impacts
Pound nets are not believed to impact habitat unless they are deployed directly on SAV (ASMFC 2000), and West *et al*. (1994) also found that they did not contribute to benthic disturbance.

3.5.2.1.13.6 Channel net

A channel net is a static gear that is attached to a structure in the water such as a dock or piling when a current is running. The current keeps the net deployed while it passively fishes for shrimp in nearshore environments (State waters).

Impact
While Higman (1952) does not specifically discuss the impacts of channel nets on habitat, it may be inferred that their effect on habitat is minimal, based on the net's catch composition and lack of contact with the bottom.

3.5.2.1.13.7 Barrier net

Barrier nets are used to collect tropical aquarium-trade species by encircling small coral heads or surrounding outcroppings with the net, and then chasing the fish into it with divers who may or may not have additional collecting gear like dipnets or slurp guns (Barnette 2001). Optionally, the net may have a bag to facilitate the capture of the fish.

Impacts
An unpublished survey of marine aquarium fish dealers done by Tullock and Resor in 1996 for the American Marine Life Dealers association found that 64% of dealers felt that the use of barrier nets was a "sustainable collection technique" (i.e. one which "does not cause physical damage to the reef environment, does not impair the captured specimen's longevity in a properly maintained aquarium environment, and does not damage non-target species such as coral polyps, other invertebrates, or non-aquarium fish"). However, Ohman *et al.* (1993) found that a type of barrier net called a moxy net, used in Sri Lanka, did break some corals during its use. Barnette (2001) concluded that any damage done by barrier nets in the southeastern U.S. region would be "infrequent and incidental in nature" and felt that the gear would "have a negligible impact on habitat".

3.5.2.1.13.8 Dip nets

Dipnets are small handheld nets used by divers to scoop up small fishes for the aquarium trade.

Impact
Barnette (2001) notes that use of dipnets may result in minor isolated impacts to coral species. No studies have focused on the potential affects of dipnets to habitat. Negative impacts may include broken coral, touching reefs, and re-suspended sediments, with the same potential effects as hand harvesting, using spears, or slurp guns. Touching coral removes a protective coating, and makes the coral more susceptible to disease and infection. Sedimentation buildup can smother

corals. Touching and re-suspended sedimentation may result from actions of divers and may occur in the absence of dipnets.

3.5.2.1.14 Spear and powerhead

Divers use pneumatic or rubber band guns (Figure 3.5.7) or slings to hurl a spear shaft to harvest a wide array of fish species. Reef species such as grouper and snapper, as well as pelagic species such as dolphin and mackerel, are targeted by divers. Commercial divers sometimes employ a shotgun or pistol shell known as a powerhead at the shaft tip, which efficiently delivers a lethal charge to their quarry. This method is commonly used to harvest large species such as amberjack. The amount of damage currently done by spears or powerheads in the Gulf of Mexico is not known, but is generally considered minor, since much less spear fishing occurs, in terms of total effort and total harvest, compared to vertical gear or longline gear. Spear and powerhead fishers do rely on finding concentrations of fish within the spearing range, and concentrations of many targeted fish species are higher on hard bottom areas with relief than on sand or mud bottoms.

Impact

Gomez *et al*. (1987) concluded that spearfishing on reef habitat may result in some coral breakage, but damage is probably negligible. Impact from divers range from touching coral with hands to the resuspension of sediment by fins. Touching coral removes a protective coating, and makes the coral more susceptible to disease and infection, and sedimentation buildup can smother corals. Impact of lines from the spear gun attached to the spear can cause additional damage. No assessment of habitat degradation or long-term impacts was discussed.

Powerheads can cause locally more intensive damage from the explosion of the shotgun shell on the sea bottom, however, velocity diminishes rapidly after shooting, there is a small surface area of impact, and low participation overall. These impacts can lead to susceptibility to coral diseases, infections or overgrowth of algae. Use of SCUBA while spear fishing allows divers to stay submerged longer, and to have a higher potential for adverse interactions with sensitive habitats. It should be noted, however, that touching and re-suspended sedimentation result from actions of divers that may occur in the absence of spears or powerheads. It may be assumed that divers pursuing pelagic species have no effect on benthic habitat due to the absence of any interaction with the benthos.

3.5.2.1.15 Slurp gun

Divers utilize slurp guns (Figure 3.5.8), which are suction-creating devices, to capture small fish in a tube alive and hopefully uninjured. Slurp guns are a minor activity in terms of total effort and total harvest compared to vertical gear or longline gear. However, slurp guns are a major gear for harvesting species for the aquarium trade. The amount of habitat damage currently done by slurp guns in the Gulf of Mexico is not known. Slurp gun fishers rely on finding concentrations of fish within their range, and concentrations of many managed fish species are higher on hard bottom areas with relief (especially coral reefs) than on sand or mud bottoms. The amount of damage currently done by slurp guns in the Gulf of Mexico is not known.

Impact

Barnette (2001) notes that use of slurp guns may result in coral breakage, but described the damage as generally very minor. Few studies have examined the potential affects of slurp guns on habitat. Negative impacts can include broken coral, touching reefs, and re-suspended sediments. Touching coral removes a protective coating, and makes the coral more susceptible to disease and infection. Sedimentation buildup can smother corals. Touching and re-suspended sedimentation may result from actions of divers and can occur in the absence of slurp guns.

3.5.2.1.16 Crab scrape

A crab scrape is a net bag attached to a rectangular metal frame with short teeth on the bottom scraping bar. The gear is dragged through shallow water areas of estuaries and bays to catch blue crabs.

Impacts

Although Barnette (2001) states that the use of crab scrapes in SAV could result in leaf shearing, uprooting of plants, and sediment resuspension; Stephan (2000) report a Chesapeake Bay study (CBP 1995) that found that while crab scrapes removed the upper parts of SAV leaves, they did not "critically" disturb roots or rhizomes. Barnette (2001) also states that crab scrapes in the southeastern U.S. are not usually deployed in SAV, because plant litter would quickly fill the net bag.

3.5.2.1.17 Oyster dredges

An oyster dredge (Figure 3.5.9) consists of a metal rectangular frame to which a bag-shaped net of metal rings is attached. The frame's lower end is called the raking bar, and is often equipped with metal teeth used to dig up the bottom. The frame is connected to a towing cable and dragged along the seabed. Oyster dredges are widely utilized in state waters along the Gulf of Mexico and the South Atlantic. Oyster dredges have been the principal commercial gear used by the industry in Texas, Louisiana, and Mississippi for over 100 years. The use of oyster dredges is prohibited in Florida and Alabama.

Impacts

Mechanical harvesting of oysters using dredges extracts both living oysters and the attached shell matrix and has been blamed for a significant proportion of the removal and degradation of oyster reef habitat (Rothschild *et al*. 1994; Dayton *et al*. 1995; Lenihan and Peterson 1998). Lenihan and Peterson (1998) observed that less than one season of oyster dredging reduced the height of restored oyster reefs by ~30%. Reduction from dredging in the height of natural oyster reefs is expected to be less than that of restored reefs because the shell matrix of natural reefs is more effectively cemented together by the progressive accumulation of settling benthic organisms, while restored reefs are initially loose piles of shell material. At an annual removal rate of 30%, restored reefs would be completely destroyed after <4 years of harvesting. Furthermore, they determined that the height reduction of oyster reefs through fishery disturbance impacted the quality of habitat due to seasonal bottom-water hypoxia/anoxia that caused a pattern of oyster mortality and influenced the abundance and distribution of fish and invertebrate species that utilize this temperate reef habitat (Lenihan and Peterson 1998). Lenihan *et al*. (2001) found that fishes abandoned degraded short reefs during anoxic periods and relocated to nearby oxygenated reefs, causing overcrowding and depletion of epibenthic crustacean prey. Their results illustrated that tall experimental reefs – those mimicking natural, ungraded reefs – were more dependable habitat for oysters and other reef organisms than short reefs – those mimicking harvest-degraded reefs – because tall reefs provided refuge above hypoxic/anoxic bottom waters. Chestnut (1955) also documented that intensive dredging over a period of years left widely scattered oysters and little substrate for future crop of oysters. Glude and Landers (1953) noted that dredges mixed the sandy-mud layer and the underlying clay and decreased benthic fauna in the fished sites versus the unfished control sites.

Langan (1998) concluded that the size frequency of oysters from the control site was biased towards older and larger specimens with poor recruitment. Oysters from the dredged site illustrated good recent recruitment, while larger specimens were not as abundant as the control site. No significant differences between the two areas were found in number, species richness, or diversity of epifaunal and infaunal invertebrates, indicating that dredge harvesting had no detectable effect on the benthic community. Sediment suspension resulting from dredging activity appeared to be localized. The study failed to evaluate fishing activity (number of participants, effort) on the dredged site.

3.5.2.1.18 Rakes and tongs

Rakes (Figure 3.5.10) are used to harvest shellfish and sponges from shallow areas such as bays and estuaries. Oyster tongs (Figure 3.5.11), similar to two rakes fastened together and facing each other like scissors, are used by fishermen from the deck of a boat. Long-handled tongs can harvest oysters as deep as 7.6 meters (Lorio and Malone 1994). In the Florida Keys, fishermen are allowed to use a four-prong rake (5 inches wide) to hook and harvest sponges from boats. Off other counties on the west coast of Florida persons are limited to diving for harvest and currently use hookah or SCUBA gear. They use blades to cut the sponges. In that fishery, about two-thirds of the sponges cut, regenerate a new sponge. In the Keys, only about one-third of the torn sponges regenerate new sponges (John Stevely 2001, personal communication).

<u>Impacts</u>
Lenihan and Micheli (2000) reported that the harvest of shellfish utilizing clam rakes and oyster tongs significantly reduce oyster populations on intertidal oyster reefs. Both types of shellfish harvesting, applied separately or together, reduced the densities of live oysters by 50-80% compared with the densities of unharvested oyster reefs. While oysters are removed, Rothschild *et al*. (1994) concluded that hand tongs probably have a minor effect on the actual oyster bar structure.

Peterson *et al*. (1987b) compared the impacts of two types of clam rakes on SAV biomass. The bull rake removed over 89% of shoots and 83% of roots and rhizomes in a completely raked area while the pea digger removed 55% of shoots and 37% of roots and rhizomes. Loss or impact on SAV by bull rake was estimated to be double the impact of the smaller pea digger rake. Peterson *et al*. (1987a) found raking with a pea digger rake reduced SAV biomass by approximately 25%. An earlier study conducted by Glude and Landers (1953) noted that bull rakes and clam tongs mixed the sandy-mud layer and the underlying clay. A decrease in benthic fauna was noted in the fished sites versus the unfished control sites.

Sponges are an important fishery in the Florida Keys and along the west coast of Florida (NOAA 1996). Sponges are dominant organisms in deepwater passes and along hard bottom habitat communities. Sponges create vertical habitat which provides shelter and forage opportunities for other invertebrates and tropical fish species. The fishery in the Keys typically employs a four-pronged iron rake attached to the end of a 5-7m pole that hooks the sponges from the bottom. While no studies document the extent of habitat damage from this gear type, it may be concluded that the harvest of sponges directly reduces the amount of available habitat, and thus may present a negative localized impact.

3.5.2.1.19 Patent tongs

Similar to hand tongs, hydraulic patent tongs are much larger and are assisted with hydraulic lift, allowing them to purchase more benthic area in pursuit of oysters. Hydraulic tongs are prohibited in GOM state fisheries. Patent tongs are not utilized in the oyster fisheries that occur in Gulf state waters (Swingle, personal communication, 2001).

<u>Impacts</u>
Rothschild *et al*. (1994) found that hydraulic-powered patent tongs are the most destructive gear to oyster reef structure because of their capability to penetrate and disassociate the oyster reef. The capability arises from the gear weight and hydraulic power. Patent tongs operate much like an industrial crane with each bite having the ability to remove a section of the oyster bar amounting to $0.25m^3$.

3.5.2.1.20 Bully net

Bully nets are similar to long-handled landing nets, but bent at a right angle to the pole. The net itself is conical with some type of line or cord attached to the end. They are used to fish for spiny lobster, principally at night when they are out in the open hunting. The fisher uses a light to locate a lobster, then places the frame of the net over the lobster while using the cord to keep the net off the lobster, then releases the cord. The net comes down on the lobster, causing it to react by swimming backwards, and further into the net for easy landing.

<u>Impacts</u>
Bully nets do have some contact with the substrate, and in the process of capturing lobster might have minor, isolated impacts on coral species (Barnette 2001).

3.5.2.1.21 Snare

A snare is used by recreational divers to capture spiny lobster. It consists of a long pole with a loop of coated wire on one end that is connected to a pull toggle on the other end. The loop is slipped around the lobster in a tight overhang or other inaccessible location, and then tightened around the lobster by means of the pull toggle, allowing relatively easy extraction of the lobster from its refugia.

Impacts

Barnette (2001) states that while there are no studies of this gear, its impact on the habitat is probably less than that of unassisted diver hand harvest, because the benthic contact necessary for leverage with hand harvest, is not needed when using a snare.

3.5.2.1.22 Hand harvest

Hand harvest describes activities that capture numerous species by hand. Target species include lobster, scallops, stone crabs, and other invertebrates.

Impacts

Impacts may result from diver contact with corals and possible coral breakage, and re-suspension of sediments, however, there is a lack of scientific investigation on potential impacts to reef fish EFH (Barnette 2001). Schleyer and Tomalin (2000) reported reef damage on South African under heavy utilization by SCUBA divers. Touching and re-suspending sediments can result from actions of divers that occur in the absence of hand harvest.

There is also a market for calcareous material and attached marine life to decorate marine aquaria. "Live rock" is an assemblage of living marine organisms attached to a hard substrate such as dead coral or limestone. Harvest of live rock in the Gulf of Mexico is addressed by the FMP for Coral and Coral Reefs of the Gulf of Mexico. Coral reefs, hard corals and sea fans are protected by Federal and Florida regulations. Taking or damaging them is prohibited. Hand harvest of conch, spiny lobster, and ornamentals is a minor activity in terms of total fishing effort and total fish harvest compared to traps, nets, vertical gear or longline gear fishing. The amount of damage currently done by hand harvest in the Gulf of Mexico is not known, but is generally considered to be minor.

3.5.2.1.23 Harpoon

A harpoon is a large spear-like impaling gear with an attached line, thrown from the deck of a vessel, and used in the swordfish and tuna fisheries.

Impacts

This gear is used to capture large pelagic species in deeper water areas, with almost no chance for contact with the bottom, and therefore it has no impact on the habitat.

3.5.2.1.24 Allowable chemicals

Collectors of live tropical reef fish commonly employ anesthetics such as quinaldine. Quinaldine (2-methyl-quinoline, $C_{10}H_9N$) is the cheapest and most available of several substituted quinolines (Goldstein 1973).

Impacts

As a result of using this compound near corals where tropical species shelter, there may be residual effects (Japp and Wheaton 1975). Short-term impacts of quinaldine include increased flocculent mucus production, retraction of polyps and failure to reexpand with a five-minute observation period, and tissue discoloration in certain species. At both study sites, octocorals were found to suffer no long-term impacts. However, a minority of Scleractinians displayed minor damage, including mild discoloration and small patches of dead tissue, three months after quinaldine treatment. Two of these specimens degraded to poor condition or displayed areas of dead tissue more than six months after initial treatment. Overall, Japp and Wheaton (1975) determined that quinaldine exposure resulted in minimal damage to corals.

3.5.2.2 Spatial analysis of fishing impacts

GIS-based analyses were run to identify areas in the Gulf where gear/habitat interactions were most likely to result in the highest impacts. The methodology for the analysis is described in Section 2.1.5.2.2. For a given gear, a series of fishing impacts index values for different habitats were used to create maps of relative fishing impacts across the habitats of the Gulf for each gear type. The impacts for a specific habitat are not additive across gears because the substantial difference in fishing effort units.

Fishing sensitivities for individual gear/habitat combinations are listed in Table 3.5.1. These fishing sensitivities were also summed across all gears for each habitat to calculate a composite sensitivity. Maps depicting the sensitivity of habitats across all considered gears are shown in Figure 3.5.16. This information was used to identify candidate areas for HAPCs under HAPC Alternative 8 (see Section 2.4.5). Across all gears considered in this analysis, the habitats most sensitive to fishing gears were corals, hard bottoms, SAV, and oyster reefs (Figure 3.5.16).

Fishing effort maps for each gear (i.e. lobster traps, stone crab traps, shrimp trawls, reef fish handlines, reef fish bottom longlines, fish traps, spear fishing, powerhead fishing, coastal pelagic handlines, shark bottom longlines) are shown in Figures 3.3.2 through 3.3.11 and the measure of effort used for each gear type is described in Section 2.1.5.2.1. The fisheries that are managed under the seven FMPs from an economic standpoint, are detailed in Section 3.3.1.

The spatial representation of fishing impacts resulted by combining the fishing effort by gear with the specific sensitivity of each habitat the gear was used on. Maps depicting the fishing impacts index for reef fish handlines on Gulf habitats are found in Figures 3.5.17a and 3.5.17b. In eco-region 1, areas with a high fishing impacts index for reef fish handlines include coral, SAV, and hard bottoms in the vicinity of the Florida Keys and the Dry Tortugas. Habitats with a high fishing impacts index for reef fish handline in eco-region 2 were SAV and hard bottoms off the Florida coast between Tarpon Springs and Dunnellon. No areas in eco-region 3 were identified as having a high fishing impacts index. In eco-region 4, the Flower Gardens and a small area of habitat near Grand Isle, Louisiana were depicted as having the highest fishing impacts index from reef fish handlines. Eco-region 5 had no areas identified as having a high impacts index for reef fish handlines.

The fishing impacts index for reef fish bottom longlines in the Gulf is presented in maps in Figures 3.5.18a and 3.5.18b. In eco-region 1, an area of offshore sand/shell between Naples and Tampa Bay, Florida had the highest impacts index for reef fish bottom longline. In eco-region 2, soft bottoms off the Florida coast between Panama City and Pensacola Bay had the highest impacts index for this gear. Eco-region 3 had no areas with a high impacts index for bottom longlines. In eco-region 4, an area of offshore sand/shell, soft bottoms, and hard bottoms between Vermilion Bay and Cameron, Louisiana had the highest impacts index. In eco-region 5, an area of soft bottoms off Baffin Bay, Texas had the highest impacts index of reef fish bottom longline.

The fishing impacts index for fish traps is shown in Figure 3.5.19. In eco-region 1, hard bottoms off the Florida coast between Cape Sable and Cape Romano were depicted as having a high impacts index for fish traps, followed by hard bottoms off Tampa Bay. For eco-region 2, hard bottoms off Tarpon Springs, Florida had the highest impacts index. There were no areas identified as having a high impacts index for this gear in eco-regions 3, 4, or 5.

Fishing impacts from spear fishing on Gulf habitats are presented in Figure 3.5.20. Areas of coral and hard bottoms in eco-region 1 in the vicinity of the Florida Keys and the Dry Tortugas were identified as having the highest fishing impacts index for spear fishing. An area of offshore hard bottoms extending into both eco-regions 1 and 2, between Charlotte Harbor and Dunnellon, Florida also had a relatively high impacts index. No areas of habitat in eco-regions 3,4 or 5 had a high fishing impacts index for this gear.

Maps depicting the relative fishing impacts from powerheads are shown in Figure 3.5.21. Habitats in eco-region 1 with the highest impacts index values for powerheads were hard bottom areas offshore of Tampa Bay. In eco-region 2, hard bottom areas off Tarpon Springs had the highest impacts index. No areas of eco-regions 3, 4, or 5 had a high fishing impacts index for this gear.

Fishing impacts for coastal pelagics handlines in the Gulf are presented in Figures 3.5.22a and 3.5.22b. Coral, hard bottom, and SAV habitats in the vicinity of the Florida Keys and Dry Tortugas in eco-region 1 had the highest values of fishing impacts index. Eco-region 2 had no areas with a high fishing impacts index value. In eco-region 3, oyster reefs near the Mississippi River had high values for coastal pelagic handline impacts. In eco-region 4, a small area of habitat near Grand Isle, Louisiana had high values. No areas of eco-region 5 were identified as having a high fishing impacts values.

Shrimp trawl fishing impacts are shown in Figures 3.5.23a and 3.5.23b. The depiction of relative impacts from shrimp trawls in the first versions of these maps was skewed by a very small patch of habitat to the north of the Florida Keys which received a very high impact index value. All other impacts relative to this value were relatively less, hence the map showed little contrast on the relative scale of the impacts index. This problem was rectified by removing this polygon from the map and re-scaling the rest of the polygons. This was justified because the polygon causing the scale problem is in fact inside an area where there is no trawling. On the revised map, the highest impact values for shrimp trawl are on two small areas of habitat – one coral and one sand – that fall just outside the Dry Tortugas National Park and the Tortugas Ecological Reserve North. These areas of habitat are shown on an expanded scale in Figure 3.5.23b.

Fishing impacts from stone crab traps on Gulf habitats are presented in Figure 3.5.24. Similarly to the shrimp map, the depiction is skewed by ten very small parcels of habitat that receive the highest impact value. These parcels are located in the Florida Keys and comprise coral (6 parcels) and seagrass (four parcels).

Lobster trap fishing impacts are depicted in maps in Figure 3.5.25. The depiction of relative impacts from lobster traps is also skewed by the same ten parcels of habitat in the Florida Keys as for stone crab traps that receive the highest impact value.

Fishing impacts of shark bottom longlines in the Gulf are shown in Figures 3.5.26a and 3.5.26b. In eco-region 1, areas of hard bottoms and sand/shell off the coast of Florida between the northern end of Charlotte Harbor and Tampa Bay had a moderately high fishing impacts index from shark bottom longline fishing. A small area of sand/shell south of Cape San Blas, Florida and another sand/shell area southwest of Cape San Blas had the highest index values in eco-region 2. In eco-region 3, an area of soft bottoms and sand/shell off the Mississippi River Delta had a high impacts index, as did an area of soft bottoms, southwest of the Delta, in eco-region 4. Soft bottoms offshore of Baffin Bay and Laguna Madre, Texas had the highest index values for this gear in eco-region 5.

The fishing impact alternatives described in Section 2.5 address potential impacts on coral reef, hard bottom, and SAV habitats and include management measures for preventing, mitigating or minimizing the adverse impacts of fishing gears specific to the locations of those habitats. These areas occur in the EEZ, have a high sensitivity to fishing gears, and generally occur in specific locations. Fishing impacts Alternative 2 (and subsequent alternatives) prohibits trawling on coral reefs. Alternative 4 limits trawl net and vessel size on hard bottom and SAV, and prohibits tickler chains on hard bottom, and prohibits anchoring while fishing on coral reefs. Other habitats are addressed in alternatives with management measures that apply to all habitats. Alternatives do not address habitats that occur only in state waters, although recommendations for review of these habitats and the gears that may affect them are provided in Section 4.4.2.2.

3.5.3 Non-fishing related activities that may adversely affect EFH

The purpose of this section is to document non-fishing activities that have the potential to adversely impact EFH, in order to support recommendations for actions to prevent the degradation or loss of such habitat. This analysis will also provide the public with information necessary to manage activities to avoid or minimize impacts to EFH. Identifying and understanding adverse impacts to EFH is expected to result in: 1) those activities that may have a direct impact being located away from EFH, especially habitat areas of particular concern, and 2) reduce or eliminate cumulative, or indirect impacts to EFH.

For purposes of discussion, this section will present non-fishing related activities in three broad categories: Physical, Water Quality, and Biological. In some cases, such as coastal development, it is recognized that the alterations usually fall within multiple categories. In order to avoid redundancy, however, each alteration is generally discussed only once.

3.5.3.1 Physical alterations

Broad categories of activities which can adversely affect EFH include, but are not limited to: dredging (ship channels, waterways, and canals), fill, excavation, fossil shellfish dredging, mining, impoundment, coastal development, discharge, water diversions, thermal additions, actions that contribute to sedimentation, introduction of potentially hazardous materials, introduction of exotic species, vessel use, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH.

3.5.3.1.1 Navigation activities

Among the principle components of the U.S. Marine Transportation System (MTS), identified in a 1999 U.S. Department of Transportation (DOT) Report to Congress (USDOT 1999) are: waterways that include the navigable waters of the United State and associated infrastructure that vessel traffic uses; ports containing marine transportation facilities where vessels transfer cargo and passengers, and include recreational access facilities and shipyards; and, vessels and vehicles that move goods and people. The waterways include both deep draft and shallow draft harbor channels that provide access to coastal and inland ports and harbors. As reported by the USDOT (1999), in 1997 ports in the Gulf of Mexico region had 484 terminals, over 25 percent of the U.S. total, and accommodated 786 berths. In 2000, Lloyd's Maritime Information Services reported eight Gulf ports among the top 25 deep-draft U.S. ports. Those ports were Houston, New Orleans, Corpus Christi, Beaumont, Tampa, Mobile, Lake Charles, and Freeport (Texas). Demand for commercial use of the MTS continues to grow as world trade, domestic use of waterways, and coastal populations increases. U.S. waterborne foreign trade alone is projected to continue to grow at an average annual rate of 3.7 percent (NOAA 1999). Hand in hand with the increased use of the MTS, will be greater competition among ports, expansion of facilities, larger ships, and increased traffic. These changes will bring greater threats to EFH.

The potential navigation-related activities, that pose threats to EFH located within estuarine and nearshore waters, can be separated into two categories: navigation support activities and vessel use. Navigation support activities include, but are not limited to: excavation and maintenance of channels (includes disposal of excavated materials); construction and operation of ports, mooring, and cargo handling facilities; construction and operation of ship repair facilities; and construction of channel stabilization structures such as jetties and revetments. Potentially harmful vessel use activities include, but are not limited to: discharge or spillage of fuel, oil, grease, paints, solvents, trash, and cargo; grounding, sinking, and prop scarring in ecologically/environmentally sensitive locations; exacerbation of shoreline erosion due to wakes;

and transfer and introduction of exotic and harmful organisms through ballast water discharge or attachment to hulls.

3.5.3.1.1.1 Channel construction and maintenance

The most conspicuous navigation-related activity in many estuarine waters is the construction and maintenance of navigation channels and the related disposal of dredged materials. The amount of subtidal and intertidal area affected by new dredging and maintenance dredging is unknown, but undoubtedly great. These activities have adversely affected and continue to adversely affect EFH by modifying intertidal and subtidal habitats. Adverse affects include filling EFH for dredged material disposal and construction of facilities, and possible release of contaminants and resuspension of fine sediments. For more extensive dredged features and related disposal sites, hydrology and waterflow patterns also have been modified. While the channel excavation itself is usually visible only while the dredge or other equipment is in the area, the need to dispose of excavated materials has left its mark in the form of confined and unconfined disposal sites, including those that have undergone human occupation and development. Chronic and individually small discharges and disturbances routinely affect water and substrate and may be significant from a cumulative or synergistic perspective. EFH effects generally observed include: direct removal/burial of organisms as a result of dredging and placement of dredged material; turbidity/siltation effects, including increased light attenuation from turbidity, contaminant release and uptake, including nutrients, metals, and organics; release of oxygen consuming substances; noise disturbance to aquatic and terrestrial organisms; and alteration to hydrodynamic regimes and physical habitat. The relocation of salinity transition zones due to channel deepening may be responsible for significant environmental and ecological change.

3.5.3.1.1.2 Port expansion

The expansion of ports and marinas has become an almost continuous process due to economic growth, competition between ports, and increased tourism. Elimination or degradation of aquatic and upland habitats are commonplace, since port and marina expansion almost always requires the use of open water, submerged bottoms, and riparian zones. Ancillary related activities and development often utilize even larger areas, many of which provide water quality and other functions needed to sustain living marine resources. Vessel repair facilities use highly toxic cleaners, paints, and lubricants that can contaminate waters and sediments. The operation of these facilities also poses an inherent threat to EFH by adversely affecting water quality in and around these facilities. The extent of the impact usually depends on factors such as flushing characteristics, size, location, depth, and configuration of the water body. For marinas, as an example, it is common that nearby shellfish beds are closed within a certain distance. It is now also a common practice to consider safe zones when siting such facilities near EFH or aquatic resources that may be threatened.

Maintenance and dredged material disposal to maintain navigable depths for vessels is a major issue at all port facilities and for many marinas. In many cases, dredged materials are contaminated, and disposal locations for these sediments are not readily available. Offshore disposal for clean and contaminated sediments is often proposed, and for some of the major ports, offshore dredged material disposal sites have been used (see Section 3.5.3.2.6). Still, contaminated sediments remain an issue as does the effects of these materials on offshore systems.

3.5.3.1.1.3 Marinas

Marinas and other sites where vessels are moored or operate often are plagued by accumulation of anti-fouling paints in bottom sediments, fuel spillage, and overboard disposal of trash, sewage, and wastewater. However, in areas where vessels are dispersed and dilution factors are adequate, the water quality impacts of boating are likely mitigated. This is especially troubling in areas where house boats have proliferated without authorization. Boating and operations at these facilities (e.g., fish waste disposal) may lead to lowered dissolved oxygen, increased temperature, bioaccumulation of pollutants by organisms, water contamination, sediment contamination, resuspension of sediments, loss of SAV and estuarine vegetation, change in photosynthesis activity, change in the nature and type of sediment, loss of benthic organisms, eutrophication, change in circulation patterns, shoaling, and shoreline erosion. Pollutants that result from marinas include nutrients, metals, petroleum hydrocarbons, sewage, and polychlorinated biphenyls (USEPA 1993).

3.5.3.1.1.4 Vessel use

The chronic effects of vessel grounding, prop scarring, and anchor damage are generally more problematic in conjunction with recreational vessels. While grounding of ships and barges is less frequent, individual incidents can have significant localized effects. Propeller damage to submerged bottoms occurs everywhere vessels ply shallow waters. Direct damage affects multiple life stages of associated organisms, including eggs, larvae, juveniles, and indirectly through water column destratification (temperature and density), resuspending sediments, and increasing turbidity (Stolpe 1997). This damage is particularly troublesome where SAV is found.

Of particular concern is the threat to seagrass beds from prop scarring. "Seagrasses are completely submerged, grass-like plants that occur mostly in shallow marine and estuarine waters. Seagrasses form small, patchy beds if their seedlings have recently colonized bare sediments or if sediment movement or other disturbances disrupt typical growth patterns. Where disturbances are minimal and conditions promote rapid growth, large continuous beds—known as meadows—may develop when patchy seagrass beds coalesce. Seagrass meadows may require many decades to form. In shallower waters of good quality, seagrass meadows may be lush and have a high leaf density, but in deeper waters, they may be sparse, or species composition may shift to a less robust species" (Sargent *et al*. 1995).

Although a number of activities may contribute to seagrass bed scarring, the most common cause occurs when boat propellers tear and cut up seagrass roots, stems and leaves. This action results in long furrows devoid of seagrasses. Once damaged or cut, it generally takes a long time, as much as 10 years, for seagrass to recover, depending on the species, extent of damage, water quality and sediment characteristics. Prop scarring can result from both commercial and recreational vessels anywhere seagrass beds exist, particularly in shallow water. A statewide study in Florida (Sargent *et al*. 1995) found the Gulf areas of Tampa Bay, Charlotte Harbor and the Florida Keys (Monroe County) having the greatest acreage of moderate to severe scarring, The Panhandle and Big Bend regions also exhibited scarred beds, but to a lesser extent. Seagrasses are more susceptible to damage than other habitats because they grow in shallow areas near the coast (Otero and Carrubba 2002). The intensity of an individual scarring event depends on the boat's draft in relation to water depth, whether it has one or two propellers, and the boat's speed. Otero and Carrubba (2002) found that scarring could potentially impact 26-35% of grassbed areas in La Parguera and 1-25% of grassbed areas in Guanica. Most scarring occurred along boat traffic routes and at popular destination areas. Aside from direct seagrass damage, scarring can increase erosion rates, resuspend sediments, change ecosystem nutrient management, fragment grassbeds, alter flow rates and current patterns, change sediment composition, and alter the distribution and diversity of the fauna (Uhrin 2001; Otero and Carrubba 2002). Uhrin (2001) examined individual prop scars in grassbeds of the La Parguera region, and reported higher flow rates near scar edges; a lower percentage of sand and a higher percentage of gravel within scars; a lower abundance of benthic fauna with closer proximity to scars; lower diversity within scars; and lower abundances of shrimps, crabs, and mollusks within scars. Scarring seemed to have a greater effect on low-mobility fauna and scars may act as barriers for such species. Scars may shift community composition toward bare sand-oriented species and the greater amount of "edge" created could increase predation rates (Uhrin 2001).

Anchor scarring is often more localized than other physical disturbances associated with vessel operation. On coral reefs and other sensitive hard bottoms, however, damage caused by anchoring may be significant (Davis 1977). Dragging or pulling anchors and anchor chains through coral reefs breaks and crushes the coral, destroying the coral formation. Several cases of anchor damage in the Flower Garden Banks National Marine Sanctuary (FGBNMS) were reported by the U.S. Coral Reef Task Force (USCRTF 2000) including a 50 m diameter area with hundreds of broken and abraded coral colonies with chain scars from a large vessel anchoring. In 1993, a tug and tow barge anchored on the East Bank causing substantial injury to over 200 coral colonies. Additional areas were damaged in 1996 and 1997 from anchoring and tow cables.

Although this document treats anchoring as a non-fishing impact, it is often practiced in conjunction with fishing activities, especially vertical gear fishing (See Section 3.5.2). Fishers do not typically use anchors on coral habitat, but they are sometimes deployed there by accident or miscalculation. An trip line anchor retrieval system would minimize dragging and bumping across coral in these instances. In addition, the vertical lifting of anchors will minimize dragging on hard bottom, benthic algae, and seagrass during the retrieval process. Presently, there are no quantitative measures of damage from anchors in the Gulf of Mexico.

3.5.3.1.2 Pipelines, cables and rights-of-way

Pipeline and navigation canals have the potential to change the natural hydrology of coastal marshes by (1) facilitating rapid drainage of interior marshes during low tides or low precipitation, (2) reducing or interrupting fresh water inflow and associated littoral sediments, and (3) allowing salt water to move farther inland during periods of high tide (Chabreck 1972), (4) reducing or altering sheet flow, and unintentional ponding. Salt water encroachment (intrusion) into fresh marsh often causes loss of salt-intolerant emergent and submerged-aquatic plants (Chabreck 1981, Pezeshki *et al*. 1987), erosion, and net loss of soil organic matter (Craig *et al*. 1979). Because vegetated coastal wetlands provide forage and protection to commercially important invertebrates and fishes, marsh degradation due to plant mortality, soil erosion, or submergence will eventually decrease productivity. Vegetation loss and reduced soil elevation within pipeline construction corridors should be expected with the continued use of current double-ditching techniques (Polasek 1997).

Pipeline landfall sites on barrier islands potentially cause accelerated beach erosion and island breaching. A Minerals Management Service (MMS) study and other studies (Wicker *et al*. 1989; LeBlanc 1985; Mendelssohn and Hester 1988) have investigated the geological, hydrological, and botanical impacts of pipeline implacement on barrier land forms in the Gulf. In general, the impacts of existing pipeline landfalls were minor to nonexistent. In most cases, due to new installation methods, no evidence of accelerated erosion was noted in the vicinity of the canal crossings, if no shore protection for the pipeline was installed on the beach (MMS 1996). Wicker *et al*. (1989) warn, however, that the potential for future breaching of the shoreline remains at the sites of flotation canal crossings where island width is small or diminishing because of Gulf and bay erosion or the sediments beneath the sand-shell plugs are unconsolidated and susceptible to erosion.

Numerous pipelines have been installed on the bay side of barrier islands and parallel to the barrier beach. With overwash and Gulf shoreline retreat, many of these pipeline canals serve as sediment sinks, resulting in narrowing and lowering of barrier islands and their dunes and beaches. Such islands and beaches are more susceptible to breaching and overwash. This type of pipeline placement was quite common in Louisiana, but has been discontinued (MMS 1996).

In the Eastern Gulf, there are currently no offshore oil and gas pipelines because no oil and gas leases have begun production. A pipeline system was being considered by industry for gas transport from the Destin Dome Area. Approximately 700 km of new trunk lines (one oil line and one gas line) and 104 km of gathering lines were projected to be constructed to support future oil and gas activities off Florida's northwest coast (as well as in support of activities in the Central Gulf Area east of the Mississippi River). It was anticipated that these pipelines would have make a landfall in Jackson County, Mississippi, and Mobile County, Alabama (MMS 1996). However, in May 2002 it was announced that the Department of the Interior would buy back the rights to the Destin Dome leases, which effectively ended all pipeline considerations.

The Gulfstream Natural Gas Pipeline System, a 608 km long pipeline between Mobile Bay, Alabama and Tampa Bay, Florida, was approved for construction in 2001 and became operational in June 2002. Live bottom impacts from pipeline burial were heavily mitigated by a multiplier of very conservative impact estimates (Gregory Boland, MMS, pers. comm.). The Federal Energy Regulation Commission concluded that the pipeline would have “limited adverse environmental impacts.” However, the Department of Commerce expressed concerns that, “this pipeline has the potential to significantly degrade sensitive marine habitats including those important to commercial and recreational fisheries.” To date, no significant degradation of sensitive marine habitat due to the pipeline has been documented (Gregory Boland, Biological Oceanographer MMS, pers. comm.).

Installation and maintenance of submarine cables, particularly fiber optic cables, is another potential threat to EFH in the Gulf of Mexico. Cables are typically installed either directly on top of the seafloor surface, buried in shallow trenches, or placed in conduits drilled under sensitive habitats such as coral reef areas. The latter technique is commonly referred to as “horizontal directional drilling”, or HDD. Although environmental studies are currently underway for this new technology to assess its effectiveness at minimizing impacts to coral reefs, visual monitoring has indicated occurrences where drilling muds used in the HDD process have escaped through cracks and fissures in the karst limestone material. These “frac-outs” as they are being called, have resulted in heavy sediment plumes and deposition on the live coral (Burkestrom, personal communication). Shallow trenching of cables is commonly performed using a seaplow for long unobstructed reaches and a ROV for specific locations such as crossing other cables. The seaplow is towed by the cable-laying vessel and has a12-inch hollow-share blade that lifts the sediment, places the cables, and allows the sediment to fall back in place (NOAA-Supplemental EA 1999). Depth of burial is 2 to 3 feet and surface disturbance, accounting for the seaplow skids, is about 19 feet across. In areas where there may be existing cables that need to be crossed, a ROV is used to bury the new cable. The ROV is positioned over the cables and a jet of water is directed downward to fluidize the sediment. The cable then sinks through the sediment and the sediments then settle over the buried cable (NOAA 1999). Both methods of installing cables below the seafloor surface disturb habitats, at least during the installation process, and should the cables become damaged or exposed, require reinstallation and disturbance again. In some cases cables are placed directly on the surface of the seafloor bottom. There is evidence that this can result in cable “whipping” or “dragging” of the seafloor resulting in disturbance and/or destruction of bottom habitats (Burkestrom, personal communication).

3.5.3.1.3 Canals and water management structures

Canals have been dredged in coastal Louisiana wetlands since the 1930s for oil and gas exploration and extraction. Most waterways are abandoned after mineral extraction is completed. Today, thousands of miles of canals crisscross these wetlands. These canals are typically dredged to 2.5 m depth and are 20 to 40 m wide. Canal lengths vary from hundreds to thousands of meters in length in the case of Outer Continental Shelf (OCS) pipeline canals (Turner *et al.* 1994). Studies have linked dredged canals, dead-end canals, and mosquito control canals to a number of undesirable effects on the wetland environment including alterations in salinity, flooding and drainage patterns, indirect loss of marsh by conversion to open water by the erosion "edge effect" of wave action, and increases in marsh erosion rates. These effects have led state and Federal agencies charged with managing the wetland resource to look for methods of mitigating canal impacts. One possible method of dealing with spoil banks after the abandonment of a drilling site is to return spoil material from the spoil banks to the canal with the hope that marsh vegetation will be reestablished on the old spoil banks and in the canal. The movement of former spoil bank material back into the canal is referred to as "backfilling" (Turner *et al*. 1994).

Canals potentially account for as much as 50 to -90 percent of the coastal wetland loss in Louisiana (Turner *et al*., 1982), with indirect impacts of canals being significantly more important than direct impacts (USDOI 1994). Where canal densities are near zero, wetland loss also tends to be near zero (Mendelssohn *et al*. 1983). The Everglades represent another example of the effects of canals and levees on coastal ecosystems. Structural marsh management has been practiced for many decades throughout the coastal Gulf of Mexico states, particularly in Louisiana. In fact, it is estimated that approximately 186,162 ha of Louisiana's coastal marshes are under some type of water control (Hartman *et al*. 1993). While some marsh management structures are emplaced to prevent loss of marsh vegetation due to saltwater intrusion or other anthropogenic changes (i.e. canal construction), studies on a variety of structurally managed tidal marshes have consistently shown significant decreases in production of most economically important marine fishery species (Gilmore *et al*. 1982; Knudsen *et al*. 1985; Wenner *et al*. 1985; Rogers *et al*. 1987; Konikoff and Hoese 1989; Pittman and Piehler 1989; Rogers 1989; Serpas 1989; Calhoon and Groat 1990; McGovern and Wenner 1990; and Rogers *et al*. 1992 a,b).

Structural marsh management and tidal water control also have the potential to accelerate marsh loss and affect overall plant community health. Semi-impoundments have been reported to increase average water depths, duration of inundation and drying events (Chabreck *et al*. 1979; Swenson and Turner 1987). Studies by Calhoon and Groat (1990), Reed and McKee (1991) and Reed (1992) have documented significantly lower rates of sediment deposition and accretion in managed as compared to unmanaged marshes. Calhoon and Groat (1990) also reported that in management situations where water levels were unable to be lowered 8-12 inches below the soil surface, above ground primary production, soil redox potential, and plant health were adversely affected. Several studies have reported greater marsh loss rates in structurally managed marshes as compared to control marshes (Calhoon and Groat 1990; Nyman *et al*. 1990; Coastal Environments Incorporated 1989). While some marsh management projects may be necessary to prevent greater losses of marsh habitat than might otherwise occur, such projects should be carefully managed to minimize deleterious effects on existing marsh habitats.

3.5.3.1.4 Coastal development

3.5.3.1.4.1 Urban development

Many of the Nation's coastal areas are under increasing pressures from population growth and related development. Currently approximately 53% of the total U.S. population lives in a coastal county, an area representing only 17 % of the total acreage of the contiguous U.S. (Beach 2002). A 1990 report by NOAA reported the Gulf of Mexico ranked fourth in total population among U.S. coastal regions and would have an estimated population of 18 million by 2010. The major population centers in the Gulf region include Houston, New Orleans, Tampa, and St. Petersburg. Although not the most densely populated coastal region, the Gulf is expected to maintain the second fastest rate of growth. The NOAA report projected that almost one-third of all Gulf counties would increase in population by more than 30 percent in the subsequent two decades and population per shoreline mile will more than double between 1960 and 2010. By 2010, Texas will have the highest ratio (1,956 per/mi), followed by Florida (1,411 per/mi).

As the population increases so does urbanization. People require places to live and work, requiring related services such as roads, parking lots, schools, water and sewer/water facilities, power, etc. These needs often are met at the expense of EFH and may adversely impact the very values that brought people to the coast. Common effects of coastal development include degraded natural habitats, declining plant and animal populations, diminishing fish and shellfish harvests, and impaired water quality (EPA 1999). A recent report by Beach (2002) states that when more than ten percent of the acreage of a watershed is covered in roads, parking lots, rooftops, and other impervious surfaces, the rivers and streams within the watershed become seriously degraded. The Beach report identifies a number of critical changes that occur as the amount of impervious surface increases, including: increased rates and volume of surface runoff; increased temperature of runoff into waterways and marshes; transport of sediments, nitrogen and phosphates, organic carbon, trace metals, petroleum hydrocarbons, and pesticides; and deceased diversity and abundance of macroinvertebrates and other food for juvenile fish. Although it is difficult to estimate the extent of impervious surface within the coastal watersheds of the Gulf region, it is reasonable to conclude that the projected rate of population growth for these areas will coincide with additional impervious surface areas.

Wetlands and adjacent contiguous lands have been filled for housing and infrastructure. Further, the demand for shoreline modifications (docks, seawalls, etc.) and navigation amenities have further modified the coast. Chemicals produced and used by people also find their way into the waters as non-point-source runoff. An example is the oil from roads, parking lots, etc. This has lowered water quality in waters and wetlands adjacent to urban developments. As a result, the quality of EFH is often much reduced.

Potential threats include: 1) conversion of wetlands to sites for residential and related purposes such as roads, bridges, parking lots, commercial facilities, reservoirs, hydropower generation facilities, and utility corridors; 2) structural stabilization (bulkheads, seawalls) of the coastal land/water interface; 3) direct and/or non-point-source discharges of fill, nutrients, chemicals, hot/cold water resulting from cooling/heating operations, and surface waters into ground water, streams, rivers and estuaries; 4) reliance on septic tanks for onsite waste disposal; 5) hydrological modification to include ditches, dikes, flood control, and other similar structures; 6) damage to wetlands and submerged bottoms; 7) increased demand for freshwater, and 8) cumulative and synergistic effects caused by association of these and other developmental and non-developmental related activities. Wetlands and other important coastal habitats continue to be adversely and irreversibly altered for urban and suburban development. One of the most serious of the adverse effects is filling for houses, roads, septic tank systems, etc. This directly removes EFH and degrades EFH that lies next to developed areas. While the total affected area is unknown, it has been extensive in much of the Gulf coast and its footprint is readily observable.

Another major threat posed by coastal development is that of non-point source discharges of the chemicals used in day to day activities associated with operating and maintaining industrial and residential facilities, for maintaining roads, for fueling vehicles, septic tanks used for onsite human waste disposal, etc. In addition to chemical input, changes that affect the volume, rate, location, frequency, and duration of surface water runoff into coastal rivers and tidal waters are likely to be determinants in the distribution, species composition, abundance, and health of Gulf of Mexico fishery resources and their habitat. In the long-term, impacts of chemical pollution (e.g., petroleum hydrocarbons, halogenated hydrocarbons, metals, etc.) are likely to adversely impact fish populations (Schaaf *et al*. 1987). Despite current pollution control measures and stricter environmental laws, toxic organic and inorganic chemicals continue to be introduced into marine and estuarine environments. Non-point source pollution is further discussed in Section 3.5.3.2.2.

3.5.3.1.4.2 Commercial and industrial development

Industrial and commercial development and operations affect EFH in a number of ways. The most inexpensive land is usually sought for development near major shipping lanes such as rivers or ports. These lands usually contain wetlands, and these wetlands are generally filled for plant siting, parking, storage and shipping, and treatment or storage of wastes or by-products. At locations near EFH these facilities are often a major source of non-point-source contaminants because of an abundance of hard impervious surfaces. Many industries are heavy water users. Water often is a vital component of the manufacturing process, serves as a cooling mechanism, and is used to dilute and to flush wastes or other by-products, which often lead to highly contaminated estuarine and bay bottom sediments (see Section 3.5.3.2.1). Many heavy industries also produce airborne emissions that often include contaminants. The problem of atmospheric deposition is discussed in Section 3.5.3.2.5.

The overall amount of EFH lost to or affected by commercial and industrial development, however, are likely to be at least as much as that from urban and suburban development. In some situations, especially for industries that produce hazardous materials, non-point source discharges can be a traumatic event, especially if there are accidental releases of chemicals. An added concern with industrial operations are contaminants that are emitted into the atmosphere. The types and levels of airborne contaminants reaching Gulf surface waters is unknown, but may have a marginal effect because of dispersal by winds.

3.5.3.1.4.3 Shoreline modification

Shoreline modification is closely associated with coastal development. Typical methods of shoreline modification include armoring (bulkheads, seawalls and revetments), beach nourishment and inlet stabilization. Many of these activities are used more frequently along dynamic coastlines subject to storm surges, erosion or sediment movement. The Gulf Coast is typical of these conditions, extending approximately 2,100 mi (Federal Emergency Management Agency 1998), it is the lowest-lying area in the United States. States bordering the Gulf have an annual rate of erosion of about three feet per year, the highest average rate of erosion in the country (The Heinz Center 2000). Louisiana has the most dynamic coastline within the region, and the most rapid rate of erosion in the nation, with rates of losses of 6,475-9,065 square km

(25-35 square miles) per year (Coast 2050 1998). Regional subsidence, changes in sediment transport patterns, and human activities are the leading factors to these high erosion rates.

The most dynamic landforms along the exposed Gulf Coast are barrier islands. Barrier islands are low-lying islands generally composed of loose sand that has accumulated through wind and/or wave action. These low-lying landforms are particularly subject to flooding, wind, waves, and sediment transport generated by severe storms and sea-level rise. The typical response to these forces is a landward retreat of the barrier islands through overwash, dune migration and inlet migration (Leatherman 1988). These processes often occur during extreme events, such as hurricanes, and result in the relocation of massive quantities of sand and sediments that can cause both short- and long-term disruption or loss of EFH. Tidal flats fronting the beach area are relocated, while tidal flats and saltmarsh areas behind the barrier island can be completely covered. The beach area can be subject to extensive erosion causing the displacement of bird and turtle nesting sites.

Efforts to stabilize the Gulf shoreline have adversely impacted barrier landscapes. Greatest application of stabilization techniques has been mainly along the Louisiana coast. Undoubtedly, efforts to stabilize the beach with seawalls, groins, and jetties have contributed to coastal erosion by depriving downdrift beaches of sediments, thereby accelerating erosion (Morton 1982). Over the last 15 years, dune and beach stabilization have been accomplished more successfully by using more natural applications such as sand dunes, beach nourishment, and vegetative plantings (MMS 1996).

Offshore extraction of sand, gravel, and shell locally destroys bottom habitat, which may eventually recover. Large-scale removal of coarse materials eliminates protective cover and changes the nature of the bottom habitat. Dredging near shores could remove protective barriers and result in greater erosion of the beach. In addition to extraction of substrate, addition of substrate, such as "beach replenishment" and "beach nourishment" can also be highly disruptive and destructive to shoal fish habitat in the adjacent nearshore areas, especially if this substrate addition results in burial or sediment overlay of live/hard bottom, coral, and/or seagrasses. Extraction of chemicals from seawater is not known to cause significant environmental damage except for loss of coastal habitat where the extraction plant is located. If solar evaporation of seawater is involved, extensive land areas may be utilized as evaporation pans (Darnell *et al.* 1976).

3.5.3.1.5 Alteration of freshwater inflow

Changes to the quantity, quality and timing of freshwater flow into estuaries and/or bays can have short-and long-term impacts to EFH. Areas within the Gulf of Mexico that have been adversely affected by changes in freshwater inflow include all of Florida, Louisiana coastal marshes, and the Texas gulf coast (EPA 2000). Canals and water management structures have altered the natural sheet flow through the Everglades to Florida Bay resulting in seagrass die-off, a declining shrimp fishery, algal blooms, and fish kills during the mid-90s. The construction of levees and dikes along the Mississippi River prevent the deposition of sediments on the coastal marshes of Louisiana, and they are instead deposited into the Gulf of Mexico. As a result, the marshes no longer can accrete at a rate sufficient to keep up with subsidence, and the rate of marsh loss has increased. In Texas, reduced freshwater inflow to estuaries has, in some cases (e.g. the Rio Grande), changed the salinity regimes necessary to maintain important commercial fish and shellfish populations.

Efforts are underway in several locations around the Gulf to restore freshwater flows into bay or estuarine systems. Examples include the Caernarvon Diversion and Davis Pond Diversion projects in Louisiana and the Everglades Restoration Project in Florida. The Caernarvon Project was designed to divert freshwater, including nutrients and sediments from the Mississippi River to the coastal bays and marshes in Breton Sound. The goal of the project is to enhance emergent marsh vegetation, reduce marsh loss and increase significant commercial and recreational fisheries and wildlife productivity in the estuary (USACOE 1998). Prior to the 1991 implementation of the project, Breton Sound was losing roughly 405 ha of marsh annually. Monitoring of the area has shown that freshwater marsh plants increased seven-fold, brackish marsh plants increased by almost half, salt marsh vegetation has decreased by more than half, and overall marshland has increased by 164 ha. In addition, oyster industry productivity has increased over three orders of magnitude, and nutrient loading to the Gulf from the Bay has been reduced (USACOE 1998).

Similarly, the Davis Pond Diversion Structure, which began operation in July 2002, transfers river water from the Mississippi to Lake Cataouache, which feeds into Lake Salvador, and eventually into the marshes in the lower reaches of the Barataria Bay estuary. Controlled releases will be designed to mimic the spring floods which occurred in the past. Operation of the structure is expected to preserve 13,355 ha of marshland and benefit 314,452 ha of the estuary. Baseline biological monitoring began in 1998, will continue as the structure becomes operational, and will include a 4-year intensive study of biological effects, followed by 46 years of long-term monitoring. Fishery-dependent data will also be assessed and hydrological and vegetational changes will be documented. Management of the salinity regimes will focus on the locations of the five and 15 ppt isohaline lines in the estuary.

A similar, but much larger, project being planned now is restoration of freshwater sheet flow through the Everglades ecosystem. Beginning as early as the late 1800s, canals were being dug through the Everglades to drain the area for development. Today, a system of more than 1,700 miles of flood control and water management canals and levees interrupt the natural sheetflow and discharge of vast quantities of freshwater into Florida Bay. More than half of the Everglades wetlands have been lost, directly or indirectly, as a result of this life plan (SFWMD 2003). A plan currently exists to redirect freshwater back into the Everglades ecosystem and enhance the functional values of the habitat for fish and wildlife.

While efforts are ongoing to restore freshwater flows to some coastal systems, attempts to divert fresh water for agriculture and municipal uses continues. Currently there are proposals to divert unspecified large quantities of freshwater from two major river basin systems that discharge into the Gulf of Mexico. The Alabama-Coosa-Tallapoosa (ACT) rivers empty into Mobile Bay and the Appalachicola-Chattahoochee-Flint (ACF) rivers empty into Appalachicola Bay. Alterations in flow regimes, including quantity, rates and timing, of these rivers may have direct effects on the EFH habitats and living marine resources of both Mobile Bay and Appalchicola Bay (www.southernenvironment.org) by changing freshwater quality and temperature, salt/fresh interface, sediment loading, etc. The full range of impacts cannot be determined until the new flow regimes are identified and understood.

For a complete discussion of the functional role of freshwater inflow to estuarine and marine waters and salinity characteristics of Gulf of Mexico estuaries see the Generic Amendment for Addressing Essential Fish Habitats (Gulf of Mexico FMC 1998).

3.5.3.1.6 Oil and gas operations

Structures placed on or anchored in the Outer Continental Shelf (OCS) to facilitate oil and gas exploration, development, and production include drilling rigs (jack-ups, semi-submersibles, and drill ships), production platforms, and pipelines. Such structure placement disturbs some area of the bottom directly beneath the structure. If anchors are deployed, the bottom habitat (immediately under the anchors and about one-third of the anchor chain) is directly impacted. Jack-up rigs and semi-submersibles are generally used to drill in water depths less than 400 m and disturb about 1.5 ha (3.7 ac) each. In water depths greater than 400 m, dynamically-positioned drill ships disturb little bottom area (except the very small area right where the well is drilled). Conventional, fixed platforms installed in water depths less than 400 m disturb about 2 ha. Tension leg platforms, installed by tethers in water depths greater than 400 m, disturb about 5 ha. The placing of pipelines disturb an average of 0.32 ha per kilometer of pipeline (MMS 1996).

Each exploration rig, platform, and pipeline placement on the OCS disturbs some surrounding area or areas where anchors and chains are set to hold the rig, structure, or support vessel in place. Exploration rigs, platforms, and pipe laying barges use an array of eight 9,000-kg anchors and very heavy chain to both position a rig and barge, and to move a barge along the pipeline route. These anchors and chains are continually moved as a pipelaying operation proceeds. The area actually affected by anchors and chains depends on water depth, wind, currents, chain length, and the size of the anchor and chain (MMS 1996).

Conventional, fixed multileg platforms, which are anchored into the seafloor by steel pilings, predominate in water depths less than 400 m. During structure removal, explosives are used to sever conductors and pilings because of the strongly overbuilt condition of these structures that must withstand probable hurricane conditions over an average 20-year life span. Upon removal the MMS requires severing at 5 m below the seafloor to ensure that no part of the structure will ever be exposed to and interfere with commercial fishing. Possible injury to biota from explosive use extends outward 900 m from the detonation source and upward to the surface. Based on MMS data, it is assumed that approximately 70 percent of removals of conventional, fixed platforms in the Gulf of Mexico in water less than 400 m deep will be performed with explosives (MMS 1996).

Alternative methodologies such as mechanical cutting and inside burning that might be used to sever pilings of multileg structures are often ineffective and are always hazardous to underwater workers. Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, or workover operations. Historically, 23 percent of all blowouts result in oil spills, eight percent result in oil spills greater than 50 barrels (bbl), and only four percent result in oil spills greater than or equal to 1,000 bbl. In subsurface blowouts, sediment of all available sizes resuspend and the bottom disturbance is within a 300 m radius. Sands settle within 400 m, but finer sediments remain in suspension for periods of 30 days or longer. Fine sediments are distributed over large distances (MMS 1996).

During offshore oil and gas exploration and production activities, a number of materials are likely to be permitted by the U.S. EPA for discharge overboard. Water-based drilling fluids, or "muds", are used during drilling operations to lubricate the drill bit and to remove cuttings. About 95 percent of all drilling mud is water, clay, and barite. The rest are additives such as starch, lime, soda ash, or sodium bicarbonate (EPA 2001). Special permits are required for oil-based muds used for high temperature or deep hole wells. During production the major discharge is produced water. Produced water is trapped within the oil or gas producing rock and brought up with the oil or gas. The water exists under high pressure, usually contains oil and metals, and must be specially treated prior to discharge (EPA 2001). In addition to drilling muds and produced water, treated sanitary and domestic wastewaters, deck drainage, and miscellaneous wastes, such as ballast water, may be discharged (EPA 2001). In 1993, MMS released the results of a report titled, *Habitat Impacts of Offshore Drilling: Eastern Gulf of Mexico*. This report investigated the area surrounding six drill site locations to determine the extent of benthic impact and whether drill sites recovered to predrilling conditions over time. The area impacted by cuttings and debris varied from a few m^2 to over 13,000 m^2. Barium levels above the natural background level of 200 ppm exhibited decreasing values away from the boreholes. The highest levels near boreholes were on the order of 50,000 to 150,000 ppm (MMS 1993). However, "those sites with the most debris and/or open boreholes attracted the most abundant and diverse fish fauna."

Recently, concern over severe methylmercury contamination, associated with sediments beneath some oil and gas platforms, has received considerable attention in the news media (The Mobile Register 2002). According to the published article, the mercury is contained in the barite used in the over one billion pounds of drilling mud that is discharged overboard. The article contains an estimate that "hundreds of thousands of pounds" of mercury may have entered the Gulf as oil and gas related discharges. The MMS refutes these allegations citing the 1995 study results of three OCS platforms in the Gulf of Mexico which included 700 sediment samples and over 800 tissue samples from shrimp, crabs, marine worms, bivalves, fish livers, and fish stomach contents. Results indicated that the concentration of total mercury is not greater in those organisms living near the platforms (less than 100 meters away) than those living away from the platforms (over 3000 meters). According to the MMS, these results support the conclusion that oil and gas platforms do not play any role in elevating levels of mercury in fish or other seafood (MMS 2002b). This study indicated that sites in shallow water return more quickly to predrilling conditions than do sites in more than 50 m of water. The newly formed subcommittee of the Gulf of Mexico OCS Advisory Board's Scientific Committee most recently addressed this issue . The Committee found that while near field sediment samples from drilling platform sites had higher levels of total mercury than samples from far field sites, levels of methylmercury did not differ between near and far field sites, and conditions around drilling platforms did not promote the conversion of mercury to methylmercury (MMS 2002c; Trefry *et al.* 2002). The committee further concluded that the contribution of methylmercury from drilling sites appears to be extremely small.

The U.S. Department of the Interior (DOI), Minerals Management Service (MMS), is responsible for leasing submerged Federal Lands on the U.S. Outer Continental Shelf (OCS) for minerals exploration, development and production. In 2000, the MMS reported that 98 percent of the gas and 91 percent of the oil on our Nation's Federal OCS was from platforms located in the Gulf of Mexico (MMS). At the end of 1999, 5,862 platforms had been installed in the Gulf of Mexico, 1,879 platforms had been retired, and 3,983 platforms remained (MMS 2000).

The 2000 MMS report indicates researchers reporting fish densities to be 20 to 50 times higher at oil and gas platforms than in nearby open water. Each standing platform serves as habitat for 10,000 to 20,000 fishes, many of which are of recreational and commercial importance (Stanley and Wilson 1997). Reggio (1987) estimated that 70 percent of all saltwater fishing trips offshore of Louisiana were destined for one or more oil and gas platforms. The MMS report also states that removal of platforms from the Gulf of Mexico has resulted in the loss of valuable reef and fishery habitat.

3.5.3.1.6.1 Faulting induced by water and oil/gas extraction

Subsurface and deep well water and oil/gas extraction along the Gulf coastal zone has been directly related to coastal subsidence in areas of Texas and Louisiana. This has contributed to the loss of large areas of coastal habitat in these subsidence districts, with a concomitant loss of EFH. Coastal subsidence is a permanent geological action and when it happens, it is unalterable. Marsh creation in a shallow water zone area is a method used to replace lost habitat, once the coastal marsh and grass beds are drowned by the rising seawater, but the success rate of this action has so far been less than 100 percent effective in survival of new plantings. Questions also remain in regards to the productive potential of the man-made marsh in relation to a natural marsh. So far, man-made marshes are significantly less productive than a natural marsh, even after 10 or more years of observation and measurement. As restoration techniques improve, so should success rates (USGS 2001a, b).

3.5.3.2 Water quality issues

As required by the Clean Water Act, estuaries in the Gulf of Mexico are classified according to "designated beneficial uses" including aquatic life support, fish consumption, or recreation. States are responsible for monitoring and assessing water quality to determine whether or not the water quality is fully, partially, or not supporting the designated use. EPA reports (1999a) that surveys conducted in 1994-95 indicated that 78 percent of the total estuarine areas in the Gulf fully supported designated uses . The 35 percent of estuarine areas identified as impaired were degraded by pathogens (fecal coliform) and eutrophication (nutrients, organic enrichment, low DO). Major activities affecting Gulf coastal water quality include: those associated with the petrochemical industry; hazardous and oil-field wastes disposal sites; agricultural and livestock farming; power plants; pulp and paper plants; fish processing; commercial and recreational fisheries; municipal wastewater treatment; mosquito control activities, maritime shipping; and land modifications for flood control and river development, and for harbors, docks, navigation channels, and pipelines. The petrochemical industry along the Gulf Coast is the largest in the United States. It includes extensive onshore and offshore oil and gas development operations, tanker and barge transport of both imported and domestic petroleum into the Gulf region, and petrochemical refining and manufacturing operations (MMS 1996).

As described above, Gulf estuary water quality problems are multifaceted. In many cases, the problems are not completely understood. Many Gulf estuaries are not routinely monitored for water quality parameters. Understanding of the natural dynamics at work in these waterbodies is, in many cases, limited. As a result of these problems, decision makers lack a general picture of estuary management, particularly with regard to water quality (Larry Goldman, USFWS, personal communication).

3.5.3.2.1 Point-source discharges

Point-source discharges from commercial and industrial development and operations pose the same risks as those listed for urban and suburban development, and the discussions under "Housing Developments" (Section 3.5.3.1.4) apply as well. Industrial point-source-discharges are of greater concern because of their quantity and content. They can alter the diversity, nutrient and energy transfer, productivity, biomass, density, stability, connectivity, and species richness and evenness of ecosystems and the communities at the discharge points and further downstream (Carins 1980). Growth, visual acuity, swimming speed, equilibrium, feeding rate, response time to stimuli, predation rate, photosynthetic rate, spawning seasons, migration routes, and resistance to disease and parasites of finfish, shellfish, and related organisms also may be altered. In addition to direct effects on plant and animal physiology, pollution effects may be related to changes in water flow, pH, hardness, dissolved oxygen, and other parameters that affect individuals, populations, and communities (Carins 1980). Some industries, such as paper mills, are major water users and the effluent dominates the conditions of the rivers where they are located. Usually, parameters such as dissolved oxygen, pH, nutrients, temperature changes, and suspended materials are the factors that have the greatest effect on EFH. The direct and synergistic effects of other discharge components such as heavy metals and various chemical compounds are not well understood, but preliminary results of research are showing that these constituents will be a major concern for the future. More subtle factors such as endocrine disruption in aquatic organisms and reduced ability to reproduce or compete for food, are being observed (Scott *et al*. 1997). Mercury was found to be high in Matagorda Bay, Texas, which was probably related to a major discharge of this element in the area in the 1970s (USDOC NOAA 1992c). There were also some temporal trends that were apparent in the data.

A report by NOAA's National Status and Trends Program (NST) examines data from six different electronic information systems maintained by USEPA and NOAA and evaluates the spatial distribution of sediment contamination (Daskalakis and O'Connor 1994). The report's conclusion that the Gulf of Mexico has more areas with high levels of contamination than other United States coasts contradicts the conclusions presented above, that are based only on the NOAA Status and Trends dataset. Although the report does not explain this discrepancy, it does state that most of the six databases provide chemical concentrations that were measured near effluent discharge sites, while the NOAA database provides chemical concentrations that were measured at randomly selected points along the Gulf Coast. Given that the Gulf of Mexico has the greatest number of waste discharge point sources, it is not surprising that the Gulf of Mexico would show a larger number of sites with high levels of contamination than do other regions (MMS 1996).

3.5.3.2.1.1 Mercury pollution

Mercury is considered to be one of the more readily bioaccumulated metals. It is volatile and is readily transformed into methyl mercury by marine bacteria (Belliveau and Tevors 1989; Bartlett and Craig 1981). There is also evidence of abiotic methylation of mercury in marine sediments (Belliveau and Tevors 1989; Moore and Ramamoorthy 1984). Biological membranes tend to discriminate against the absorption of ionic and inorganic mercury, but they allow relatively free passage of methyl mercury and dissolved mercury vapor (Boudou *et al*. 1991; Eisler 1987). Evans and Engel (1994) suggest that the most important mechanisms for mercury accumulation in a marine food web are via the consumption of sedimentary detritus and benthic invertebrates.

Mercury is toxic to all biota, including birds, mammals, and aquatic organisms. Mercury causes lethal and sublethal effects on the central nervous, cardiovascular, immunologic, reproductive, and excretory systems of mammals (Agency for Toxic Substances and Diseases 1993). Low doses of metallic mercury vapors have been associated with adverse effects on the kidney and central nervous system of mammals. In birds, mercury can adversely affect growth, development, reproduction, blood and tissue chemistry, and behavior (Eisler 1987). In aquatic organisms, mercury can produce impairment, growth reduction, osmoregulatory disturbances, developmental effects, or death.

An illustration of the extremely toxic effects of industrial discharges of heavy metals into bays and estuaries is the current mercury pollution of approximately one-third of Lavaca Bay in Texas. In July 1970, the Texas State Department of Health (TDH) closed part of Lavaca Bay due to elevated mercury levels in oysters. In 1971, Lavaca Bay was reopened to oyster harvesting. In 1988, TDH closed the area around the Alcoa PCO site to the taking of finfish and crabs due to elevated tissue mercury concentrations. On February 23, 1994, the Alcoa PCO site was placed on the National Priority List (Superfund) with an effective listing date of March 25, 1994. In late 1995, Alcoa began the Remedial Investigation phase of the study which included the collection and analysis of over 10,000 environmental samples from surface waters, sediments and biological organisms (Alcoa 1996, 1997a, and 1997b) near the facility.

The results of the remedial investigation show that, in most areas, historical mercury contamination is being buried by sedimentation (both naturally and man-made through active dredging of the nearby ship channels). Areas containing elevated surface mercury concentrations are limited to the areas directly offshore of the plant where the main source of the discharge occurred, and other small areas where sediment hydrodynamics have inhibited active sedimentation. Mercury tissue concentrations in fish and blue crabs within the TDH closed area average > 1 ppm total mercury, thus the continued closure of the area for public health reasons.

Since methylation does take place in aquatic environments and bioaccumulates/bioconcentrates, it can be found in higher trophic level predators at substantially elevated levels in areas, such as the Lavaca Bay closed area, where significant mercury contamination has occurred. Also, since mercury accumulation in fish and other aquatic organisms takes place in many organs, including muscle tissue, contaminated fish can transfer mercury to the human population eating seafood from contaminated areas.

3.5.3.2.2 Non-point source runoff

Despite the significance of point source contamination, non-point source runoff has had the greatest impact on coastal water quality. Non-point pollutant sources include agriculture, forestry, urban runoff, septic tanks, marinas and recreational boating, and hydromodification. The Gulf of Mexico drainage area encompasses more than 4 million km^2, more than 55 percent of the total area of the coterminous U.S. (EPA 1999b). Waterways draining into the Gulf transport wastes from 75 percent of U.S. farms and ranches, 80 percent of U.S. cropland, hundreds of cities, and thousands of industries not located in the Gulf's coastal zone. Urban and agricultural runoff and septic tanks contribute large quantities of pesticides, nutrients, and fecal coliform bacteria (MMS 1996).

3.5.3.2.2.1 Pesticides

Over 10 million pounds of pesticides were applied within the Gulf of Mexico coastal area in 1987, making it the top user of pesticides in the country (USDOC NOAA 1992a). The Gulf of Mexico ranked highest in the use of herbicides (6.6 million pounds) and fungicides (over 1.0 million pounds), and a close second in the use of insecticides. The Atchafalaya/Vermilion Bays, the Lower Laguna Madre, and Matagorda Bay ranked in the top 10 estuarine drainage areas in the U.S. for carrying pesticides to coastal waters. Although ranking high based on inputs, when NOAA normalized pesticide use for risk to estuarine organisms (USDOC NOAA 1992a), the Gulf fared better; Tampa Bay and the Lower Laguna Madre were the only two drainage basins in the top 10 (MMS 1996).

3.5.3.2.2.2 Eutrophication and bacterial pathogens

Eutrophication is the accelerated production of organic matter, particularly algae, in a water body (NOAA 1999a). It is usually caused by an increase in the amount of nutrients, primarily nitrogen and phosphorous, being discharged into the water body. Although a natural process, eutrophication has been greatly accelerated by human activities. A variety of impacts may occur as a result of increased algal production including: nuisance and toxic algal blooms, depleted dissolved oxygen (see hypoxia section), and loss of submerged aquatic vegetation. These impacts directly threaten EFH in a number of ways. Epiphytes, or small algae, grow on the surface of plants or other objects and an over-abundance can cause the loss of submerged vegetation by encrusting the leaf surfaces and blocking light to the leaves. Large blooms of seaweed can also block the available light to submerged aquatic vegetation as well as smother corals and other EFH. The Gulf of Mexico is significantly affected by eutrophication. Nitrogen and phosphorus loadings in the Mississippi River and Gulf coastal waters have risen dramatically over the last three decades (Rabalais 1992). NOAA (1999a) reports almost half of the estuaries in the Gulf are characterized as having high levels of eutrophic conditions. Those estuaries with the highest levels are Florida Bay, Lake Pontchartrain, Calcasieu Lake, the Mississippi River Plume, Corpus Christi Bay and the Laguna Madre system. Fourteen estuaries are characterized as having moderate levels of eutrophic conditions, and only six were characterized as having low-level conditions. The report also predicted that of the 38 Gulf estuaries studied, 23 would develop worsening conditions over the next 20 years, six of them to a high degree (Mississippi River Plume, Lake Pontchartrain, Corpus Christi Bay, Upper and Lower Laguna Madre, and Baffin Bay).

In addition, the Nutrient Enrichment Subcommittee of the Gulf of Mexico Program estimated that more than 379,000 pounds of phosphorus and over 1.87 million pounds of Kjeldahl nitrogen are discharged into the Gulf on an average day, with 90 percent of both elements coming from the Mississippi River system (Lovejoy 1992). Nutrient over-enrichment has been a particular problem for the Lower and Upper Laguna Madre in Texas; Lake Pontchartrain, the Mississippi River, and Barataria Bay in Louisiana; Mississippi Sound, Pascagoula Bay, and Biloxi Bay in Mississippi; and Perdido, Pensacola, Choctawhatchee, and St. Andrews Bays in Florida (Rabalais 1992).

A good indicator of coastal and estuarine water quality is the frequency of fish kill events and closures of commercial oyster harvesting. Of the 10 most extensive fish kills reported in the United States between 1980 and 1989, five occurred in Texas (3 in Galveston County, 1 in Harris County, and 1 in Chambers County) (USDOC NOAA 1992a). Because oysters are bottom-dwelling filter feeders, they concentrate pollutants and pathogens. The oyster industry is a good indicator of impacts from septic tank runoff pollution. About one-half of the harvestable shellfish beds in Louisiana are closed annually because of *E. coli* bacteria contamination. Most of the productive oyster reefs in Gulf estuaries are in conditionally approved areas or areas where shellfish harvesting is affected by predictable levels of pollution (USDOC MMS 1996).

3.5.3.2.2.3 Other toxic compounds

Since 1984, the National Oceanic and Atmospheric Administration's (NOAA) National Status and Trends Program (NST) has monitored the concentrations of synthetic chlorinated compounds such as DDT, chlordane, polychlorinated biphenyls (PCBs), tributyltin, polynuclear aromatic hydrocarbons (PAH's), and trace metals in bottom-feeding fish, shellfish, and sediments at coastal and estuarine sites along the Gulf of Mexico (USDOC NOAA 1992c). Sites were randomly selected to represent general conditions of estuaries and nearshore waters away from waste discharge points. Eighty-nine sites were sampled along the Gulf Coast and compared with more than 300 sites located throughout the U.S. coastal areas. Chemical concentrations exceeding natural levels are considered contamination. NOAA defines "high" levels of a compound class as when the logarithmic value is more than the mean plus one standard deviation of the logarithm. The following summarizes NOAA's findings for both sediments and shellfish (MMS 1996).

Oysters were sampled for five years as part of NOAA's (NST) National Mussel Watch Program. Examining the entire U.S. coastal area, the highest chemical contamination consistently occurred near urban areas. Fewer sites along the Gulf were contaminated than along other coastlines. Of the six U.S. urbanized areas showing highest levels of organic compound contamination in shellfish, the only Gulf Coast site listed was Mobile, Alabama. Sites located along the Gulf having oysters containing at least three compounds with "high" concentrations included Panama City and Choctawhatchee Bay, Florida; Mobile Bay, Alabama; Lake Borgne, Louisiana; and Galveston Bay, Brazos River, Corpus Christi, and the Lower Laguna Madre, Texas (O'Connor 1992). Moderately elevated concentrations of pesticides and PCBs appeared along the central Louisiana coastline and at isolated stations in Matagorda and Galveston Bays, Texas (Texas A&M University 1988). Within Gulf samples, the highest concentrations of chlorinated hydrocarbons were observed along the Mississippi to northern Florida coast, and at stations in Tampa Bay. High cadmium concentrations in oysters occurred at some sites in some years, but the reasons for the changes in cadmium levels could not be explained. The DDT concentrations in oysters showed significant decreases over the five years sampled, primarily since DDT use is no longer allowed. In Terrebonne Bay, Louisiana, arsenic showed consistent decreases while zinc increased each year (MMS 1996).

Sediment data were also collected and examined (O'Connor 1992). As in benthic samples, higher levels of sediment contamination were associated with highly populated areas, and, in general, sites in the Gulf of Mexico had lower concentrations of toxic contaminants than the rest of the country (sampling period from 1984 to 1988). Again, the likely reason for this finding was that sampling sites in the Gulf of Mexico coastal areas were away from urban areas that are typically characterized as having large numbers of point-source discharges. The distribution of organochlorine loadings in sediment followed those observed in oysters (Texas A&M University 1988). The number of sites in each state having concentrations among the top 20 nationally for selected classes of contaminant compounds in sediments was provided (USDOC NOAA 1992c). Florida had 17 of the sites; Mississippi and Texas each had one site; and Alabama and Louisiana had none. Florida was also identified as having sites in the top 20 nationally for all selected contaminants. Florida was one of four states that have contaminant concentrations in the top 20 nationally for all selected toxics; Mississippi's site ranked high only for PAHs; and the Texas site had high DDTs. Sediments with chemical concentrations exceeding high levels were identified in Tampa Bay, Panama City, St. Andrew Bay, and Choctawhatchee Bay, Florida; Biloxi Bay, Mississippi; and Galveston Bay, Texas (MMS 1996).

Also, as part of NOAA's NST Program, petroleum hydrocarbons were measured in Gulf of Mexico oyster and sediment samples. The results showed (1) total hydrocarbon concentrations were lower than those at east and west U.S. coast locations, probably because the sites in the Gulf are farther removed from large point sources, such as large cities and industrial areas; (2) chronic petroleum contamination is taking place due to contamination of the discharge from the Mississippi River, but also possibly from oil and gas operations and/or natural seepage of hydrocarbons along the Gulf of Mexico coastline; and (3) water quality degradation from oil and gas operations is not taking place to such an extent that it outstrips more urbanized U.S. coastal areas that do not have as many oil operations (MMS 1996).

3.5.3.2.3 Hypoxia

Hypoxia, commonly referred to as "dead zones", is a direct threat to EFH and occurs when dissolved oxygen concentrations are below those necessary to sustain most animal life. Since 1993, a zone of hypoxia affecting up to 10,360 square km (4,000 square miles) of bottom waters on the inner continental shelf from the Mississippi River delta to the upper Texas coast has been identified during mid-summer months. In 1999, it was 20,720 square km (8,000 square miles), which is about the size of the state of New Jersey (CENR 2000). Researchers have expressed concern that this zone may be increasing in frequency and intensity. In 2000, the National Science and Technology Council Committee on Environment and Natural Resources (CENR) issued the first integrated assessment of hypoxia in the northern Gulf of Mexico. The report concluded that the Gulf hypoxia is caused primarily by excess nitrogen delivered from the Mississippi-Atchafalaya River Basin (MARB) in combination with stratification of Gulf waters. The principal sources of nitrate in the MARB are river basins that drain agricultural land in southern Minnesota, Iowa, Illinois, Indiana, and Ohio. About 56 percent of the nitrate enters the Mississippi River from the Ohio River. This is an area of intense corn and soybean production, where large amounts of nitrogen from fertilizer and manure are applied to soils every year. Nitrate not being used by crops or removed by geochemical processes, is subject to being leached into streams and groundwater within the MARB. About 90 percent of the nitrogen comes from nonpoint sources, with the remainder coming from point sources (CENR 2000).

One of the effects of hypoxia is degradation of bottom and near-bottom habitats. Benthic fauna studied within the area exhibited a reduction in species richness, abundance, and biomass that was much more severe than has been documented in other hypoxia-affected areas (Rabalais *et al*. 1995). Growth of marine organisms is inhibited when dissolved oxygen is less than about 5.0 ppm (CENR 2000). At dissolved oxygen (DO) levels less than 2.0 ppm, a variety of physiological responses and behaviors occur among organisms. Motile fishes, cephalopods, and crustaceans leave the area. Responses of non-motile benthic organisms range from pronounced stress behavior to death. At 0.0 ppm DO there is no sign of aerobic life. In areas where the oxygen concentrations are below 0.2 ppm, the sediment is typically black, and sulfur-oxidizing bacteria form mats on the seafloor (CENR 2000). In areas affected by hypoxia annually, complete recovery of a climax community may not occur (Harper and Rabalais 1997). Although the Mississippi/Alabama inner shelf has the potential for bottom-water hypoxia, and low oxygen concentrations have been documented, such events are not considered frequent or widespread (Rabalais 1992).

Mississippi River nutrient concentrations and loadings to the adjacent continental shelf changed dramatically during this century, with an acceleration of these changes since the 1950s (Turner and Rabalais 1991; Justic *et al*. 1995a, 1995b). Nitrogen is the principal nutrient yielding excess organic matter sedimentation to the Gulf hypoxic zone. Nitrogen export from the Mississippi River system has increased two-to-seven-fold over the last century.

The biotic community responds to hypoxia-anoxia in a fairly predictable way (Rabalais *et al*. 1997). Motile organisms leave an area when oxygen levels fall below 1.5-2.0 mg/l, less motile invertebrates die at oxygen levels below 1.5 mg/l, infauna display stress below 1.0 mg/l, and a fairly linear decrease in benthic abundance occurs below 0.5 mg/l. Direct mortality, altered migration, reduction in suitable habitat, increased susceptibility to predation, changes in food resources and susceptibility of early life stages occur for fish during hypoxia.

Coastal Louisiana shrimp catch data show a negative relationship between catch and percent area of hypoxic waters in shrimp catch sampling cells (Zimmerman *et al*. 1997). Decreased catches of epibenthic and demersal fisheries species have been shown, through fisheries-independent sampling, to occur in areas of lower oxygen. Other potential fisheries impacts may include: concentration of fishing effort leading to increased harvest and localized overfishing; low catch rates in directed fisheries; and changes in recruitment due to impacts on zooplankton. However, Zimmerman *et al*. (1997) confuse the issue later in their paper, when they state that the inverse relationship between catch and percent hypoxia in statistical cells is most likely a reflection of the characteristics of the Louisiana shrimp fishery; not a habitat-related phenomenon. Changes in distribution and abundance of fish species could result in loss of commercial and recreational fishing opportunities (Hanifen *et al*. 1997). Diaz (1997), in reviewing hypoxic areas worldwide, found reduced or stressed fisheries populations to be common in areas where hypoxia occurs.

If nutrient loads from the MARB do not increase, the current size and severity of Gulf hypoxia would most likely remain the same. If, however, the nutrient loads increase, potentially from increased populations and food production, the hypoxia may expand (CENR 2000) and further threaten EFH. Long-term effects of chronic hypoxia, coupled with continued loss of adjacent estuarine habitats on important northern Gulf Fisheries are uncertain.

3.5.3.2.4 Desalination, entrainment, impingement, and thermal cooling water discharges

As the population has continued to increase for some coastal areas of the Gulf, particularly eastern Florida, the future demand for drinking water has become a significant concern. At the same time, the amount of water pumped from existing wells is being reduced so that lakes and wetlands can recover from many years of pumping. One approach to dealing with these issues is seawater desalination. Desalination is a process by which the salt is removed from seawater, generally through reverse osmosis, and the drinking water is sent for further treatment while the remaining concentrated seawater is discharged. Two potential threats to EFH exist as a result of the desalination process: the quantity of seawater needed; and discharge of the concentrate. About 45 to 50 million gallons of seawater are required to produce 25 million gallons of drinking water and the concentrated seawater is twice the salinity of Gulf water (www.tampabaywater.org). In Florida, at least two municipal desalination plants are proposed to begin operating within the near future. The Tampa Bay facility co-located with Tampa Electric Company's Big Bend power plant in southern Hillsborough County is to produce 25 mgd of drinking water. This facility will intercept 44 mgd of the 1.4 billion gallons a day the power plant already uses for cooling water, remove the salt, and mix the concentrate back into the cooling system before it is discharged from the plant. Salinity of the cooling water will increase about 1-1.5 percent above average but additional mixing and dilution is expected to bring the salinity close to background levels (www.tampabaywater.org). The second desalination plant is the Gulf Coast Desalination Facility to be located near the coast of Pinellas and Pasco counties, with a high likelihood of being co-located with the Anclote power plant. The Gulf Coast plant is expected to begin operating in 2008, producing 25 mgd.

The thermal effluent cooling water discharges from coastal power plants have a pronounced effect on bay and estuary organisms and nearshore open Gulf habitat. Hot, thermal effluent discharges in the hot summer months usually lead to very high mortality levels for eggs, larvae, and sub-adult marine organisms, while the same thermal effluent discharges in the cold winter months are beneficial to some living marine organisms such as manatees. This has become a concern particularly in the state of Florida where a large manatee population exists and power plants have been discharging warm water for as long as 30 years. Manatees use the artificially induced warm water to winter-over. Research indicates that manatees return to the same discharge every year and that calves may learn the same routine (www.floridaconservation.org). The warm water discharges associated with power plants in Florida are now viewed as potential "refugia", or protected areas, for manatees, and as Florida deregulates its power industry there is concern regarding the future of these sites.

A secondary, and major effect, is the entrainment of larval, juvenile and adult fish and invertebrates on power plant filter screens at the water intake points, which leads to very high mortality levels, especially in the spawning seasons for the various marine organisms. Power plant water intakes filter large volumes of water and this results in many planktonic marine and estuarine organisms being trapped and killed on the filtering screens.

Contaminant spills may occur in the Gulf Intracoastal Waterway (GIWW) and other navigation channels due to collisions between barges, ships, or between such vessels and other structures. The chemical spill impact on the immediate and surrounding habitat is generally determined by the following: type of chemical, time of day, weather conditions, and geographic location. Most barge spills in the GIWW are extremely damaging to the marshes and estuaries due to the narrow confines of the GIWW itself and the usually isolated and hard to reach, geographic location of the spill. This usually necessitates a long response time before clean-up crews can first get to the spill site, thus allowing a very large area to subsequently be impacted. This also leads to a long clean-up time period with subsequent further impact to the environment from the clean-up operation itself. This clean-up operation impact is usually unavoidable.

Chemical spills kill fish, crabs, shrimp, benthic animals, birds, mammals, and most of the marsh plants. The degree of mortality depends on the chemical itself and its interaction with water and air, depth of water, time of year, time of day and local weather conditions. Recovery of the impacted area is usually measured in months or years.

3.5.3.2.5 Atmospheric deposition

Atmospheric deposition results when nitrogen and sulfur compounds or other substances, such as heavy metals and toxic organic compounds, are transformed by complex chemical processes and deposited on the earth away from the original sources. The transformed chemicals return to the earth in either a wet or dry form. Wet forms may be rain, snow, or fog; dry forms may exist as gases or particulates. Once these transformed substances reach earth, they can pollute surface waters, including rivers, lakes, and estuaries (USEPA 1994b). Current estimates indicate that a significant fraction of the total nitrogen entering coastal and estuarine ecosystems arises from atmospheric deposition. Along with other sources of nitrogen (fertilizers, sewage, etc.), atmospheric nitrogen becomes a source of nutrients that can lead to eutrophication of the waters.

Although the full range of impacts to EFH remain unclear at this time due to a lack of adequate scientific research, recent studies conducted by the Tampa Bay Estuary Program confirm the significant contribution of atmospheric deposition to total nitrogen loading to the Tampa Bay. It is estimated that direct atmospheric deposition of nitrogen to Tampa Bay accounted for approximately 25 percent of the total nitrogen-loading rate (TBNEP 2000). Similar results found in other coastal embayments confirm the importance of considering atmospheric deposition as a source of nitrogen. Estimates for the Chesapeake Bay indicate that 20-30 percent of the nitrogen entering that bay is from atmospheric deposition from local and distant sources (Chesapeake Bay Program 1997).

3.5.3.2.6 Ocean dumping/disposal of dredged material

No unpermitted ocean dumping of industrial and commercial waste material occurs in the Gulf of Mexico. Only sediments removed from the bottom of waterbodies, commonly referred to as dredged material, are routinely dumped in the Gulf, and only if it meets environmental criteria. The Gulf-wide artificial reef-building program instituted by the Gulf states is not considered ocean dumping.

The disposal of dredged material usually occurs through one or more management options: upland disposal in a regulated landfill, upland confined disposal facilities (CDF), unconfined aquatic disposal, and subaqueous confined aquatic disposal (CAD). EPA (1997) lists 23 Federally-approved sites for dumping dredged material in the Gulf of Mexico. Those sites, and their approximate size in square nautical miles (snm), are: Tampa Bay (4 snm), Pensacola Offshore (6 snm), Pensacola Nearshore (2.48 snm), Mobile (4.8 snm), Pascagoula (18.5 snm), Gulfport East (2.47 snm), Gulfport West (5.2 snm), Mississippi River Gulf Outlet (6.03 snm), Mississippi River Southwest Pass (3.44 snm), Barataria Bay (1.4 snm), Houma (2.08 snm), Calcasieu River, 3 sites (11.17 snm), Sabine-Neches, 4 sites (15.5 snm), Galveston (6.6 snm), Freeport Harbor-45 Ft. Project (2.64 snm), Freeport Harbor (1.53 snm), Matagorda Ship Channel (.56 snm), Corpus Christi (0.63 snm), Homeport Project (1.4 snm), Port Mansfield (0.42 snm), Brazos Island Harbor (0.42 snm), Brazos Island-42 Ft. Project (0.42 snm).

Ocean dumping of dredged material cannot occur unless a permit is issued under the MPRSA. The decision to issue a permit for dredged material is made by the COE, using EPA's environmental criteria and subject to EPA's concurrence. EPA's environmental criteria under the MPRSA basically provide that no ocean dumping will be allowed if the dumping would cause significant harmful effects, or the material proposed to be dumped is not adequately characterized. However, the process for evaluating potential environmental effects resulting from ocean disposal of dredged material is quite complex and difficult. A tiered approach is used to determine the suitability of the material for ocean disposal, ranging from review and extrapolation of existing information to sophisticated bioassay testing for toxicity (Moore, *et al.* 1999).

3.5.3.2.6.1 Aquaculture/mariculture

Aquaculture is the farming of aquatic organisms, including finfish, shellfish (mollusks and crustaceans), and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, and protection from predators. (FAO 2000). Mariculture is saltwater aquaculture and includes coastal, offshore, saltwater pond and saltwater tank operations (Goldburg, *et al*. 2001). Mariculture represents approximately one-third of the U.S. production, by weight, of total aquaculture production. The majority of U.S. aquaculture production is for freshwater catfish (*Ictalurus punctatus*) around the Mississippi Delta area. Other mariculture production around the Gulf of Mexico region include shrimp, and oysters, clams, crawfish and more recently red drum. During the past few years the Texas shrimp farming industry has expanded to about 70%-80% of the U.S. farmed shrimp market. The predominance of commercial aquaculture in the southeastern U.S. occurs in earthen ponds (SRAC 1998). Although a number of environmental effects may result from aquaculture operations, only those that have a reasonably likely effect on EFH - organic pollution and eutrophication, chemical pollution and habitat modification – are discussed here. The leading cause of organic and chemical pollution originates from waste products associated with farming, uneaten food, feces, urine, mucus, and dead fish. Studies have shown that less than 30% of the feed or fertilizer nitrogen and phosphorous added to the ponds is recovered through harvest (SRAC 1998). Often times the waste is carried in the effluent by episodic discharges to estuarine or coastal waters during heavy rain or draining of the ponds, leading to localized nutrient loading and contributing to eutrophication. Discharge from shrimp ponds in Texas is reported as a source of localized water pollution (Goldburg *et al*. 2001). The use of nets pens and cages in areas of EFH would tend to create localized increases in organic pollutants, but the exact nature of these impacts is not known.

Many different types of chemicals might be used during aquaculture production and although they vary depending on the aquaculture facility, they include antibiotics, parasiticides, pesticides, hormones, anesthetics, various pigments and minerals and vitamins. The potential threats of these chemicals entering the marine environment can be as severe as acute toxicity to marine organisms (Goldburg *et al*. 2001).

Direct alteration of EFH by mariculture operations in the Gulf of Mexico area is generally in the form of landfill of nearshore or estuarine areas for land-based tank operations or siltation and eutrophication of shallow lagoons for shrimp farming (Goldburg *et al*. 2001)

It is expected that aquaculture production in the U.S. will continue to expand as wild stocks decline or remain limited and the demand continues to rise. Although aquaculture production of oysters has declined in recent years, production of other species common to the Gulf, such as shrimp, clams and catfish have grown steadily (Goldburg *et al*. 2001). Texas is a particularly likely candidate for increased production of shrimp (Lopez-Ivich 1996). As aquaculture production expands over the coming years, so will the potential threats to EFH.

3.5.3.3 Biologic alterations

3.5.3.3.1 Blooms (toxic and nontoxic)

Brown tide first appeared in Texas's Upper Laguna Madre (ULM) in the early 1990s. This chrysophyte, identified as part of the blue-green algae family, possibly *Aureoumbra lagunensis*, persisted for over 8 years. Brown tide reduces light available for seagrass photosynthesis and caused significant seagrass losses in the ULM (McEachron, *et al*. 1998).

The bloom ran its course and disappeared from the ULM-Baffin Bay System by the late 1990s (McEachron, *et al.* 1998). The disappearance may have been aided by the more than 25 inches of rain that fell in four days during October 1996. This lowered the salinities (from >50 ppt) to <10 ppt in some areas. The brown tide organism was still present but not in bloom proportions demonstrated by counts from researchers (50-100 cells/ml versus previous 500,000 cells/ml). Researchers also reported high densities of the larval dwarf surf clam, a major grazer of the brown tide organism. While there has been some reduction of seagrass beds, it has not been extensive. These are deeper areas and are expected to take longer to recover.

Red tides are a natural phenomenon in the Gulf, primarily off Florida, Texas, and Mexico. Red tides are blooms of a dinoflagellate that produces potent toxins, harmful to marine organisms and humans. They can result in severe economic and public health problems and are associated with fish kills and invertebrate mortalities.

A red tide began off the Texas coast on September 18, 1997 near Pass Cavallo and Sargent's Beach (McEachron, *et al.* 1998). The bloom progressed southward into Mexico during October, with the majority of the bloom occurring in the Gulf waters off of Padre Island. The duration of the offshore bloom was September 18 through November 23, 1997. On November 21, 1997, red tide was reported inside bay waters near Corpus Christi and Port Aransas, Texas. The duration of this bloom lasted from November 21 through December 10, 1997, with areas of high cell counts lasting through January 19, 1998. A minimum estimate of mortality was 21.8 million aquatic organisms (16.5 million occurring in the surf and 5.3 million in the bays). The species killed included (in the millions): anchovies (5.5), menhaden (4.6), Atlantic bumper (3.9), ghost shrimp (1.8), scaled sardines (1.7) and mullet (1.2) (McEachron, *et al.* 1998). There are ongoing studies to determine whether human activity that increases nutrient loadings to Gulf waters contributes to the intensity of red tides (US DOI MMS 1996).

In 1991, persistent and widespread blooms of cyanobacteria were reported in Florida Bay over hundreds of square kilometers (Butler *et al*. 1995). Blooms occurred again each year from 1992 through 1995. The cyanobacteria blooms caused widespread sponge mortality in central Florida Bay where the blooms occurred. Sponges in Florida Bay provide shelter for numerous animals including stone crabs *(Menippe mercenaria),* octopus (Octopus spp.), spider crabs *(Mithrax* spp.), and juvenile spiny lobster *(Panulirus argus).* These sponges are valuable habitat for spiny lobster which depend on them for shelter during their early life history (Butler *et al*. 1995). The exact cause of the blooms is presently unknown.

3.5.3.3.2 Introduction of exotic species

Invasive species have been identified as a significant contributor to the loss of biological diversity throughout the world (Vitousek *et al*. 1996; Mack *et al*. 2000). Occurring in almost all regions of the U.S., invasive species have major ecological impacts including: 1) outright loss of native species or decline in abundance of native species due to competition for food and space, predation, and habitat alteration; 2) changes in ecosystem structure and function, such as nutrient cycling and hydrology; 3) rearrangement of trophic relations; or 4) the introduction of virulent plant and animal diseases and parasites (EPA 2001). The control or eradication of nonindigenous species is difficult and consists of either biological or nonbiological efforts. A recent report by the EPA Gulf of Mexico Program (2001) reports that Florida and the Gulf lowlands are second only to Hawaii in the magnitude of nonindigenous species introductions, and the total number of aquatic species introductions to Florida and Texas is nearly 2 to 3 times the U.S. 50-state average. The nonindigenous species that are of concern in the Gulf region include: various viruses and disease organisms, the zebra mussel, the edible brown mussel, a variety of mammals, numerous species of fish and other vertebrates, and various wetland and aquatic plants. Summaries of a recent inventory of nonindigenous species in the Gulf region, prepared by the EPA- Gulf of Mexico Program (2001), are shown in Tables 3.5.2 through 3.5.5.

3.5.3.4 Marine debris

The occurrence of marine debris in oceans, coastal waters, beaches, intertidal flats, and vegetated wetlands throughout the world has become a serious problem. Marine debris is considered to be any man-made, solid material that enters the marine environment either by direct dumping or from the discharge of rivers, storm drains, etc. The debris ranges in size from microscopic plastic particles (Carpenter *et al*., 1972), to mile-long pieces of drift net, discarded plastic bottles, bags, aluminum cans, etc. Animals can become entangled in netting or fishing line, or ingest plastic bags or other materials. In laboratory studies, Hoss and Settle (1990) demonstrated that larval fishes consume polystyrene microspheres. Investigations have also found plastic debris in the guts of adult fish (Manooch, 1973, Manooch and Mason, 1983). Based on the review of scientific literature on the ingestion of plastics by marine fish, Hoss and Settle (1990) conclude that the problem is pervasive. Shaver and Plotkin (1998) documented that between 1983 and 1995, debris was the primary cause of death of seven out of 473 sea turtles found stranded along the south Texas coast. Three of these deaths were attributed to large fishing hooks (2) and monofiliment line (1). During a 2000 Florida Coastal Cleanup, it was reported that 46 animals were found entangled in marine debris, including 16 by fishing line, and six by fishing nets/rope.

Most attention given to marine debris and sea life has focused on the issues of entanglement and ingestion by threatened and endangered marine mammals and turtles, on birds. Historically, little scientific information has existed on the effects of marine debris on marine habitats. More recently however, the scientific community is attempting to quantify the impacts of marine debris on habitat types. Of particular note is the recent study conducted by Chiappone *et al*. (2002) to document the abundance and impacts of remnant commercial and recreational fishing gear on reef biota in the Florida Keys National Marine Sanctuary. Forty-five sites were surveyed in the summer of 2000, covering approximately 8,040 m^2. Almost 90% of the 110 debris items found consisted of monofilament line (38%), wood from lobster pots (20%), combined fishing weights, leaders, and hooks (16%), and rope from lobster traps (13%). Documented impacts associated with the 110 debris items were reported as 54 (49%) causing tissue abrasion, other damage, and/or mortality to 161 individuals or colonies of sessile invertebrates (sponges, branching gorgonians, fire coral, scleractinian corals, and the colonial zoanthid *Palythoa mammilosa*. This is an area that requires additional scientific investigation to better understand the relative impacts that remnant fishing gear has on EFH.

3.5.4 Analysis of non-fishing activities/effects on EFH

3.5.4.1 Sensitivity indices for non-fishing effects

The sensitivity maps created from the analysis described in Section 2.1.4.2.2.2 are presented in Figure 3.5.27. These maps indicate that habitats at highest risk include coral reefs, seagrass, oyster bars, the pelagic zone, and benthic algae. This is mainly due to the fact that these habitats are comprised of biological organisms rather than physical substrate and are therefore more susceptible to chemical and physical impacts. Highest risk areas were predicted for the Florida Keys where extensive coral reef and seagrass habitats are present, the northwestern coastline of Florida where extensive seagrass beds are present, and coastal Louisiana where extensive marsh habitats exist. Smaller, but high risk areas also were mapped for seagrass, marsh, mangrove, and oyster bar habitats within Florida and Texas coastal estuaries.

By summing the indices for each non-fishing effect, the relative overall impact of each non-fishing effect can be calculated as in Figure 3.5.28. Based on this analysis, dredge and fill activities appear to have the greatest potential effect on fisheries habitats. This is due to the fact that dredging and filling involve physical disturbances that can result in the conversion of a highly productive and structurally complex habitat (e.g., seagrass) to a less productive bare sand habitat (e.g. during dredging of a channel) or the conversion of an aquatic habitat to an upland land mass. Other activities with potentially significant effects appear to be oil and gas operations/industrial spills and altered freshwater inflows. Oil and gas operations have the potential to result in oil spills that can have an acute toxic effect on living habitats (e.g. seagrasses, wetlands) and also contaminate the pelagic zone making it uninhabitable by aquatic organisms in the short term (MMS 2002a). Oil and gas operations also include disturbance to habitats by pipeline and oil platform construction (MMS 2002a). Other types of chemical spills and chronic point and non-point source pollution can damage biogenic habitats as well (Williges *et al*. 1998; Preston and Shackelford 2002).

Altered freshwater inflows affect the salinity zone in estuarine and nearshore areas and can directly affect the distribution of seagrasses, oyster bars, reef systems, and the pelagic environment (Polychaete Research 1981; PBS&J 2001; Richter *et al*. 1996). The type of freshwater alteration measured in this analysis was the presence of dams, which reduces freshwater flow to an estuary. However, other types of flow alterations can occur, for example through extensive urban development which results in the creation of impervious surface areas (pavement, rooftops) which divert rainfall from groundwater recharge to drainage canals and streams, thereby increasing the rate and volume of freshwater to the estuary. This second type of freshwater alteration was not measured since a more detailed analysis of hydrologic features would be required to evaluate this effect.

Increases in one or several of the non-fishing effect activities could have significant effects on EFH in the Gulf of Mexico. Some effects, such as dredging and filling, could have greater impacts than fishing gear effects since a complete loss of habitat may occur rather than incidental damage. Although difficult to quantify, future population growth and development is likely to result in further losses of EFH due to increases in dredging and filling, point and non-point source pollution, and associated nutrient loading and eutrophication effects. If oil and gas operations along the Florida coastline were ever approved, risks to sensitive nearshore and estuarine habitats would increase, with potential effects ranging from neglible to moderate (MMS 2002a).

3.5.4.2 Non-fishing impacts index

The spatially discreet non-fishing effects values, calculated according to the methods described in Section 2.1.4.2.3.1, were multiplied by the sensitivity index (Table 3.5.6) values and normalized to calculate an index value for each habitat/non-fishing effect (Table 3.5.7). The resulting tables are presented in Appendix H and represent a quantitative measure of the non-fishing effects within each statistical zone and habitat type. These data were condensed by summing the total effects values for each habitat type by zone and plotted on the maps in Figure 3.5.29 to show the relative distribution of scores throughout the Gulf of Mexico. These data represent the relative non-fishing effects values for each statistical zone and depth zone.

A summary of the estuarine and nearshore effects by NMFS statistical unit is also presented in Figure 3.5.30 (weighting factors) and Figure 3.5.31 (total non-fishing effects scores). The results are discussed by eco-regions (delineated as described in Section 2.1.3.3.2.4) in the following sections.

3.5.4.2.1 Eco-region 1

On a relative scale, non-fishing impacts in the Florida Keys are fairly low, despite extensive evidence of impacts to coral reefs and seagrasses. This low score is partially due to a low non-point source score since the land area (and associated urban/agricultural land use area) within this zone is small compared to much larger watersheds contributing to estuarine systems like Tampa Bay and Charlotte Harbor. In addition, the number of wastewater treatment plants is low compared to other larger statistical zones. This is primarily due to a large number of septic tank systems in the Keys which are not accounted for in this analysis. In the Dry Tortugas area west of the Florida Keys (statistical grid unit 2), the total population and urban activities are fairly low, and so the calculated total effects scores for this zone are relatively low. Areas with large contributing watersheds, high populations, and highly developed coastal areas such as in statistical grid units 4 and 5 (Charlotte Harbor, Sarasota Bay, and Tampa Bay estuaries) had much higher non-fishing effects scores. Impacts in these areas were mainly due to dredge and fill, shading effects, boating activities, shoreline modification, freshwater alterations, and non-point source pollution.

3.5.4.2.2 Eco-region 2

Statistical zones in eco-region 2 had relatively low impact scores despite having large areas of sensitive habitats, primarily seagrass beds and oyster bars. Coastal areas along this region are relatively undeveloped (few urban areas) and so the primary impacts are due to non point source pollution (from agricultural land use), boating impacts, and dredge and fill (intercoastal waterways). Several large power plants occur along this coastline.

3.5.4.2.3 Eco-region 3

Impacts in this area were mainly due to dredge and fill, boating activities, oil and gas operations, altered freshwater flows, and industrial activities. The east and central Louisiana coastal area and Mobile Bay have large industrial areas for oil and chemical processing. The coastal wetlands of Louisiana are being lost due to subsidence/loss of accretion from historic freshwater flow patterns that are now altered by water diversion structures.

3.5.4.2.4 Eco-region 4

This region has several large industrial and urbanized areas, particularly in Galveston Bay (Zone 18). Several other coastal areas along Louisiana and Texas have significant nearshore and offshore oil drilling operations (Zones 13, 15, 16, and 17). Non-fishing impacts in these zones are mainly due to oil and gas operations, dredge and fill, toxic chemical releases, structural shading (from oil platforms in inshore areas), and industrial activities. Hypoxia was a large effect in the western zones.

3.5.4.2.5 Eco-region 5

This region includes the Freeport Texas area, which includes several large chemical processing plants. Areas to the south of Freeport include marsh, mangrove, seagrass, and oyster bar habitats. This area is relatively undeveloped compared to Galveston Bay and so non-fishing impacts in these zones are mainly due to dredge and fill, boating impacts, non-point source pollution, and freshwater inflow alterations.

Based on the tables in Appendix H and the impact maps, the impact values calculated in this analysis correlated well with the level of human development and population densities across the Gulf of Mexico. Another apparent trend was the difference in scores between the nearshore and estuarine depths relative to the distribution of zones. The nearshore total effects were typically greater in Zones 14 through 21 (Louisiana to Texas), than in Zones 1 through 9 (which are all along the Florida coastline). This trend is due to the lack of offshore oil production along

Florida’s coast. Oil related activities were a predominant factor in assessing nearshore effects and most of these activities within the Gulf of Mexico occur in the areas of Louisiana and Texas.

4 ENVIRONMENTAL CONSEQUENCES

This section of the EIS provides an analysis of potential environmental impacts that may result from the implementation of the No Action alternative and the other alternatives, including the Preferred Alternatives, presented in Section 2 of this document. Elements such as climate, physiography, and geology are not generally affected by localized activities, although they are presented here as required. As described in Section 2.0 *Essential Fish Habitat Alternatives*, the alternatives are presented in three main parts:

4.1 Consequences of alternatives to describe and identify EFH;

4.2 Consequences of alternatives to define and establish HAPC;

4.3 Consequences of alternatives for preventing, mitigating, or minimizing the adverse effects of fishing.

Research recommendations, conservation recommendations, and assessment of the short and long term productivity, irreversible and irretrievable commitments are presented in Sections 4.4, 4.5, and 4.6, respectively.

4.1 Consequences of alternatives to describe and identify EFH

There are no direct environmental or physical impacts caused by the designation of EFH, however there are indirect positive and negative consequences, including that EFH designation is likely to result in controversy within the human environment. Proponents of large areas of EFH may object if it is described for small areas, and vice versa. Indirect effects will occur as a result of two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. Second, Federal actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the Act.

Although EFH alternatives are developed separately for each of the seven Gulf FMPs, each FMP contains the same set of alternatives based on the Concepts presented in Section 2.1.3.4. The lack of direct impacts leads to consequences that are the same for alternatives within a concept *across* FMPs. This section initially addresses consequences of each EFH concept that apply to all FMPs, and considers indirect consequences specific to FMPs where appropriate.

Under Section 305(b)(2) of the Act, each Federal agency must consult with NOAA Fisheries regarding any action authorized, funded, or undertaken by the agency that may adversely affect EFH. The EFH regulations require that Federal agencies prepare EFH Assessments as part of the consultation process (50 CFR 600.920(e)). Under Section 305(b)(4)(A) of the Act, NOAA Fisheries must provide EFH Conservation Recommendations to Federal and state agencies regarding any action that would aversely affect EFH. Under section 305(b)(3) of the Act, Councils may comment on and make recommendations to Federal and state agencies regarding any action that may affect the habitat, including EFH, of a fishery resource under Council authority. State, local, and other non-Federal entities are not required to consult with NOAA Fisheries and the Council regarding the effects of actions on EFH, if those activities do not require Federal licenses, permits, or funding.

The following sections provide comparisons of environmental effects for each of the five EFH Concepts. Since implementation of the No Action alternative is expected to leave the existing environment unchanged except for continuation of existing impacts, the effects of this alternative is the same as that described in Section 3.0, *Affected Environment,* and impacts are merely summarized in this section. Impacts of the remaining alternatives – each a different means by which to establish EFH – are discussed in this section.

The designations of EFH and HAPC are expected to provide greater protections indirectly for fish habitats through additional review and scrutiny in existing regulatory processes. No direct negative effects on the environment are anticipated. Indirect effects of the designation include protection of habitat through the changes in fishery management including modifications to fishing practices, e.g. gear modifications, area restrictions, and in the future, harvest limits, license and permit limitations, etc. These actions are addressed under section 4.3 *Consequences of alternatives for preventing, mitigating, or minimizing the adverse effects of fishing.*

4.1.1 Consequences for the physical and biological environment

The designations of EFH by FMP are expected to provide greater protections for fish habitats indirectly through review that is additional to existing scrutiny required in existing regulatory processes. None of the EFH alternatives have any direct effects on the geological or oceanographic features that comprise the physical environment of the Gulf of Mexico. None of the alternatives considered will change the general bathymetry; geological configuration; water parameters such as temperature, salinity, chemical composition or any other physical components of the Gulf of Mexico. Additionally, designation of EFH through any of the proposed alternatives will not have any indirect impacts on the oceanographic features of the Gulf of Mexico. However, there will be indirect effects as a result of two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act. Use of certain fishing gears can have impacts on the substrate and biogenic structure, such as coral reefs, and siltstone or claystone banks, as described in Section 3.5.1 (fishing threats). Alternatives to prevent, mitigate and minimize adverse fishing impacts on EFH are presented in Section 2.5 and their consequences on the physical environment are presented in Section 4.3.

Similarly, none of the EFH alternatives will have any direct effects on the estuarine, nearshore or offshore habitats that are part of the biological environment of the Gulf of Mexico (described in detail in Sections 3.2.1 and 3.2.2) and are utilized by fishery resources (Sections 3.2.4). The consequences on marine habitats are identical to those for the geological component of the physical environment, thus these will be presented together in Section 4.1.1.1.

Adverse impacts have occurred on geological structure and marine habitats used by many fishes. Describing and identifying EFH will not by itself restore degraded habitat, but resulting consultations may help to arrest the current degradation and prevent future adverse impacts of non-fishing activities. This may allow the habitat to begin a recovery from past impacts, if it has not been replaced with a different habitat type or destroyed. The effectiveness of consultations on mitigating potential adverse impacts will likely depend on the level at which a managed fish species depends on the habitats at risk; however, uncertainty of the role that specific habitat plays in fish production limits the conclusions one may draw on the effects of designating EFH. The Gulf Council and NOAA Fisheries can currently regulate fishing activities that have potential to adversely impact EFH, but designation of EFH will help to focus additional attention in this area.

Non-fishing activities that have and continue to adversely affect geological structure and marine habitats include dredging, scraping, sand and mineral mining, oil and gas exploration activities, laying pipelines, modifying deposition, and coastal development (Turner and Calhoon 1987; MMS 1996; Coast 2050, 1998; MMS 2002a). Some of these actions could homogenize the seabed surface, cause sedimentation to cover surface features, cause subsidence, or form barriers to river-transported sediments (Section 3.5.3). Other activities that affect marine habitats include dumping and release of contaminants. In some cases, the impacts of non-fishing activities on EFH occur in areas removed from the location where the activity takes place. For example, rivers may transport high levels of suspended sediments that travel long distances to the marine environment. A wide definition of EFH may, therefore, have benefits in terms of ensuring the consultative process associated with non-fishing activities includes as many potentially damaging activities as possible.

Regardless of which EFH concepts or alternatives are determined to be preferred, environmental sites of special interest, such as the Tortugas Ecological Reserves, Flower Garden Banks HAPC, Florida Middle Grounds HAPC, Shrimp Sanctuary, Cooperative Texas Shrimp Closure, Southwest Florida Seasonal closure, Central Florida Shrimp/Stone Crab Separation Zones, and others will retain existing protections from adverse fishing activities, as well as any additional general protections from non-fishing and other fishing impacts that are provided by the designation of EFH.

The following sections discuss the potential different indirect effects that the different EFH alternatives may have on the geological component of the physical environment and all marine habitats. Concept 3 is not discussed, as it was considered but rejected by the Council.

4.1.1.1 Consequences for the geological features and marine habitats

4.1.1.1.1 Alternative 1. No Action.

Although the No Action concept is contrary to the legal requirement of the Magnuson-Stevens Act to describe and identify EFH for those species in the management units of FMPs, the No Action concept provides a baseline against which environmental consequences of the EFH alternatives may be compared. No direct positive or negative impacts to geological features or marine habitats will occur as a result of the alternatives developed under Concept 1. Existing designation of EFH would roll back to conditions prior to the approval of portions of the 1998 Generic EFH Amendment, and the "significant opportunity to make a difference in improving the success of sustainable fisheries and healthy ecosystems" envisioned by NMFS (NMFS 1998) would not be realized. Loss or degradation of habitat would be more likely than under the other EFH alternatives that result in EFH designation. Fish populations currently threatened by habitat loss could continue to decline, and additional fish populations may become threatened as habitat loss continues. If declines in productivity occur, then this impacts commercial and recreational fishers dependent on these fish populations, potentially leading to lost revenues, increased economic uncertainty or less access to fish.

However, although NOAA Fisheries and the Gulf Council would not conduct consultations under the auspices of EFH requirements, consultations on some Federal actions that might negatively affect the geological substrate and marine habitats (dredge and fill, mining, OCS activities, coastal development, etc.) would continue as they have prior to implementation of the EFH regulations and the 1996 reauthorization of the M-S Act. These consultations would occur under the auspices of legislation such as Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. If there are no EFH designations, the consultations may not be as effective, and would not be able to be linked to a specific species or FMPs, and Federal agencies would not be required to respond to NOAA Fisheries or Gulf Council comments in writing stating why they have or have not taken the comments into consideration.

Additionally, several fishery management actions taken by NOAA Fisheries and the Gulf Council prior to the EFH regulations that effectively protect biogenic structures such as coral reefs, siltstone or claystone banks, and other marine habitats would be maintained and provide protection to habitats that are functionally important to one or more managed species. These include prohibitions on the use of explosives, chemicals, and anchoring in sensitive areas; designation of no trawl and other marine protected areas (MPAs) such as at the Tortugas Ecological Reserves, Florida Middle Grounds or Flower Gardens Banks; and some fishing gear restrictions. These prior actions are presented in detail in Section 1.5, History of management and Appendix A.

4.1.1.1.2 Alternative 2. Status quo.

The 1998 Generic Amendment defined EFH for the estuarine component as "all estuarine waters and substrates (mud, sand, shell, rock and associated biological communities), including the sub-tidal vegetation (seagrasses and algae) and adjacent inter-tidal vegetation (marshes and mangroves)." For marine waters, EFH is defined as "all marine waters and substrates (mud, sand, shell, rock, hard bottom, and associated biological communities) from the shoreline to the seaward limit of the EEZ" (Generic Amendment, 1998). There was no differentiation between more ecologically important habitats and all potential habitat used by managed species and lifestages.

The Generic Amendment considered the following areas EFH for individual FMPs:

- For the Red Drum FMP, virtually all estuarine and nearshore habitats out to depths of approximately the 22 fathom isobath (40 m);

- For the Reef Fish FMP, all estuarine, nearshore and offshore habitats to the 275 fathom isobath (550 m);

- For Coastal Migratory Pelagics, all estuarine, nearshore and offshore habitats to the 110 fathom isobath (200 m);

- For Shrimp, all estuarine, nearshore and offshore habitats to the 60 fathom isobath (110 m);

- For Stone Crab, all estuarine, nearshore and offshore habitats to approximately the 27 fathom isobath (50 m);

- For Spiny Lobster, all estuarine, nearshore and offshore habitats to the 40 fathom isobath (80 m) between Tarpon Springs and the Florida Keys; and

- For Coral, the East and West Flower Gardens Banks, Florida Middle Grounds, and scattered coral reef communities or solitary specimens (on hard bottom).

No direct positive or negative impacts to geological features or marine habitats will occur as a result of the each of the Alternatives 2. However, the entire Gulf of Mexico EEZ was designated as EFH under the 1998 Generic Amendment. Indirect effects therefore, include NOAA Fisheries and the Gulf Council potentially consulting on all Federal actions in the EEZ that might negatively impact fish habitat including the geological substrate under fish habitat (such as dredge and fill, mining, OCS activities). Comments generated through the consultation process would be based on the importance of the EFH habitats to fish managed under the seven FMPs, and would be expected to provide some level of protection to the geological features and Gulf fish habitats.

Impacts to geological resources and features that result in changes that are irreversible, or contribute to, trigger, or accelerate any geologic process such as erosion or marine landslides in these areas identified as EFH would require consultation. Similarly, adverse impacts to marine habitats such as dredging, scraping, laying pipelines, sedimentation, and direct removal or shading (shoreline hardening or pier/dock construction for coastal development) would require consultation. The sources of such impacts would come primarily from non-fishing activities and secondarily from gear interaction with bottom features (e.g. damage to reefs from anchors, nets, trawl doors, etc.). These impacts could be locally important if unique geological features are permanently damaged. The activities that may result in negative impacts may be prevented, modified or mitigated to reduce or eliminate the negative impact on the geological feature or marine habitat if the Federal agency changes the action based on the NOAA or Council consultation. Because these alternatives would not differentiate between particularly important versus all potential habitats used by species in an FMP, no one area would receive greater protection than another based on EFH designation.

No changes to circulation patterns or oceanographic conditions (e.g., water temperature, dissolved oxygen levels, and salinity) are expected to result from the alternatives developed under Alternative 2.

Existing fishery management protection measures that protect geological features and biogenic structures as described under Alternative 1 would continue. All fishing activities that may negatively impact the geologic features, biogenic structures, and marine habitats throughout the Gulf EEZ must be reviewed and alternatives to prevent, mitigate or minimize these actions must be considered (see Section 4.3).

4.1.1.1.3 Alternative 4. Known distributions of species in the FMU. (Preferred Alternative for the Coral Reef FMP)

The Preferred Alternative for the Coral FMP is Alternative 4, known distributions of species in the FMU. This includes all areas mapped as hard bottom and coral reef including the East and West Flower Garden Banks, Florida Middle Grounds, southwest tip of the Florida reef tract, and predominant patchy hard bottom offshore of Florida from approximately Crystal River south to the Florida Keys, and scattered along the pinnacles and banks from Texas to Mississippi, at the shelf edge (Figure 2.3.13).

No direct positive or negative impacts to geological features or marine habitats will occur as a result of the alternatives developed under Concept 4; however the indirect effects will be the same to those described under Concept 2 above, except they will cover different geographical areas for each FMP, as described below.

The designation of EFH resulting from the Alternatives 4 expands the designation of EFH under Alternatives 2 (from the 1998 Generic Amendment), since it is species-based rather than habitat-based, and includes the life stages of *all* managed species in each of the seven FMPs as described in Sections 2.3.1.3 (Red Drum), 2.3.2.3 (Reef Fish), 2.3.3.3 (Coastal Migratory Pelagics), 2.3.4.3 (Shrimp), 2.3.5.3 (Stone Crab), 2.3.6.3 (Spiny Lobster), and 2.3.7.3 (Corals). Information used under Concept 4 includes distribution data from the mid-1980s and earlier; and EFH designated under this Concept may include areas of historical distribution for overfished species or species undergoing overfishing, and thus may cover a larger area than the species currently occupy.

Although the Alternative 4 includes more species and life stages for each FMP than Alternatives 2, the total area for any FMP does not extend as far out into the US EEZ as do the resulting combined designations of the 1998 Generic Amendment.

When comparing the descriptions of EFH by individual FMP, some of these alternatives describe areas larger, and others smaller than the Alternative 2 for each FMP, affecting the total area to which consultations would apply and for which adverse fishing activities must be reviewed for prevention, mitigation or minimization:

- For the Red Drum FMP, EFH under Alternative 4 extends to approximately the 20-22 fathom isobath, an area identical to Alternative 2.

- For Reef Fish, Alternative 4 is slightly larger than Alternative 2 for the entire Gulf, and extends to the 295 fathom isobath.

- For Coastal Migratory Pelagics, EFH under Alternative 4 is the same as Alternative 2, and identifies all pelagic waters out to approximately the 110 fathom isobath.

- For Shrimp, EFH extends out to approximately the 325 fathom isobath throughout the Gulf. This covers an area that extends out much further than the 60 fathom isobath designated under Alternative 2.

- For Stone Crab, EFH under Alternative 4 extends out to the 27 fathom isobath throughout the Gulf and is identical to Alternative 2.

- For Spiny Lobster, EFH extends out to approximately the 100 fathom isobath across the entire northern Gulf under Alternative 4. This is far more area than Alternative 2, which identifies all waters out to the 40 fathom isobath between Tarpon Springs, FL and the Florida Keys.

- For Coral, EFH under Alternative 4 (Preferred Alternative) includes all areas mapped as hard bottom and coral reef including the East and West Flower Garden Banks, Florida Middle Grounds, southwest tip of the Florida reef tract, and predominant patchy hard bottom offshore of Florida from approximately Crystal River south to the Keys, and scattered along the pinnacles and banks from Texas to Mississippi, at the shelf edge. This is the same as the designation of coral EFH under Alternative 2.

Activities that may occur in areas beyond the 325 fathom isobath will not require EFH consultations under each Alternative 4, as they would under each Alternative 2. This would mostly be limited to deep-water OCS activities. All known fishing activities managed by the Gulf Council occur landward of the 325 isobath, thus there would be no difference in fishing activities which would require review to prevent, mitigate or minimize adverse actions between Concept 2 and Concept 4.

4.1.1.1.4 Alternative 5. Areas of highest species density, based on the NOAA Atlas.

These Alternatives use Level 2 information (density data) where available in the NOAA Atlas (NOAA, 1985). Density distributions are used as an indication of preferential habitat use (value) by species and life stage under these alternatives. The only FMP for which there is not an Alternative 5 is the Coral Reef FMP. These alternatives results in EFH that is discrete or smaller than EFH described under Alternatives 2, 4 and 6, for Red Drum, Coastal Migratory Pelagics, Stone Crab, and Spiny Lobster. For the Shrimp FMP the extent of EFH is the slightly smaller under this alternative to that under Alternative 4 for areas off Texas through Mississippi, but is substantially smaller than the extent of Alternative 4 off Florida. The converse is true for the Reef Fish FMP; EFH for Alternative 5 is slightly smaller than Alternative 4 for regions off Florida, however EFH extends only between the 20 fathom and 100 fathom isobaths from Texas to Alabama. The full historic spatial distribution of species is not accounted for under this alternative.

The consultation process will continue to review the same types of Federal actions that may impact the geological features and all marine habitats, as those described under Alternatives 2 or 4. However, since the area designated as EFH for any FMP is more discrete, areas not described and identified as EFH will not be reviewed in light of the explicit EFH requirements of the M-S Act. Yet, if all these alternatives were chosen as preferred, the combined outcome would be a total area of EFH that is only slightly smaller than the combined areas under Alternative 4.

4.1.1.1.5 Alternative 6. Areas of highest species density, based on the NOAA Atlas and functional relationships. (Preferred Alternative for the Red Drum, Reef Fish, Coastal Migratory Pelagics, Shrimp, Stone Crab, and Spiny Lobster FMPs)

The Preferred Alternatives for identifying EFH for all FMPs except Coral is Alternative 6, areas of highest species density based on the NOAA Atlas and functional relationships. Combined, the area comprises all the estuarine, nearshore, and offshore areas of the Gulf of Mexico out to the 100 fathom depth contour (Figures 2.3.1 (Red Drum); 2.3.2 (Reef Fish); 2.3.3 (Coastal Migratory Pelagics); 2.3.4 (Shrimp); 2.3.5 (Stone Crab); and 2.3.6 (Spiny Lobster).

No direct positive or negative impacts to geological features or marine habitats will occur as a result of Alternative 6. The designated area can include both Federal and non-Federal waters, and the consultation process will continue to review the same types of Federal actions that may impact the geological features and all marine habitats, as those described under Alternatives 2 or 4. However, activities in areas not described and identified as EFH under this Alternative will not be reviewed in light of the explicit EFH consultation requirements of the M-S Act. The stress that these impacts may pose to marine environments may be reduced through the consultation process.

Designation of EFH under Alternative 6 relies on Level 2 information for those species and life stages that it exists. Designation of EFH under these alternatives is limited by the availability of data necessary to identify habitat based on function (feeding, growth to maturity, and spawning), although proxies were identified and used where possible.

- For the Coastal Migratory Pelagics FMP, the EFH designated by Alternative 6 is identical to that under Alternative 4, however this is not the case for the other FMPs.

- For Red Drum, areas identified as EFH under Alternative 6 include all those in Alternative 5 and all Gulf estuaries, areas in the nearshore between the 5 and 10 fathom isobath from Crystal River to Naples, and nearshore waters north of the Florida Keys. EFH under Alternative 6 is larger than under Alternative 5, but smaller than Alternatives 2 or 4.

- For Reef Fish, EFH under Alternative 6 includes all habitats and waters out to the 100 fathom isobath, which is slightly less than the region covered under Alternative 4 off Florida, but smaller than under Alternative 5.

- For Shrimp, EFH under Alternative 6 from the US-Mexico border to longitude 87°W is slightly smaller than Alternative 4, and slightly large than Alternative 5. In the eastern Gulf, Alternative 6 is significantly different than Alternatives 4 and 5. It essentially extends out to the 30 fathom isobath, but does not include any known hard bottom or coral areas. This makes it larger than Alternative 5, and approximately half the area covered by Alternative 4.

- For Stone Crab, Alternative 6 includes all habitats and waters included in Concept 5, with the addition of all estuarine and nearshore waters to 10 fathoms around the Gulf.

- For Spiny Lobster, Alternative 6 includes all habitats and waters included in Concept 5, with the addition of hard bottom areas from Tarpon Springs to Naples between 5 and 10 fathoms, and additional areas along the north side of the Florida Keys to about 15 fathom depth.

- For Coral, Alternative 6 includes only those areas identified as known, living coral reef, the East and West Flower Garden Banks and the corals in the Dry Tortugas area.

The combined EFH designation under this Alternative is not significantly different than for Alternatives 4, and will cover the entire Gulf out to the 100 fathom isobath.

4.1.1.2 Consequences for the biological environment

This section considers the consequences on all parts of the biological environment excluding marine habitats that are considered in conjunction with geological features in Section 4.1.1.1.

Designation of EFH has no direct impact on the biological environment, but is likely to result in indirect impacts due to two other provisions of the M-S Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. NOAA Fisheries and the Gulf Council have no authority to manage fishing gear in state waters, unless the Secretary of Commerce preempts management authority. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act, as extensively described under Section 4.1.3.

4.1.1.2.1 Fishery resources

4.1.1.2.1.1 Fishery resources under Federal FMPs

Describing and identifying EFH will have no direct positive or negative impact on the fishery resources of the seven Gulf FMPs. All existing fishery management protective actions as a result of the fishery management plan process would continue to be applied inside and outside an EFH designation under any of the EFH concepts or alternatives.

The intent of the EFH requirements is to benefit fish through improved habitat protection. This may occur through indirect effects that result from the two provisions of the M-S Act. One requires the Gulf Council and NOAA Fisheries to minimize to the extent practicable adverse effects of fishing on EFH, pursuant to Section 303(a)(7) of the Act. The other requires Federal actions that may adversely affect EFH be subject to consultation and/or conservation recommendations under Sections 305(b)(2)-(4) of the Act. Where the EFH triggered consultation might occur is based on the spatial extent of EFH resulting from each of the alternatives under each concept for EFH. Thus the indirect consequences in relation to the consultation process will be the same for fishery resources, as described in detail in Section, 4.1.3.

These potential improvements to habitat protection and potential benefits to populations of fish will occur in the future and cannot be completely predicted in advance, particularly since it depends on the level at which a managed fish species or lifestage relies on the habitats at risk. Additionally, uncertainty in the role that specific habitats play in fish production limits the conclusions one may draw on the effects of designating EFH. Positive results also depend upon the degree that Federal agencies incorporate NOAA mitigative or conservation recommendations for each individual Federal activity that is reviewed.

Consultations would not occur for pre-existing non-fishing impacts, and there would not be a retroactive implementation of measures to mitigate these, so impacts from on-going non-fishing activities will likely continue into the future. Existing fishing activities are under review in this EIS, and are subject to management actions to address adverse impacts to the degree practicable and are discussed in Section 4.3.

The no-action concept provides a baseline of no EFH designation. While consultations would occur as before the EFH requirements, the consultations would not have the benefits of the EFH requirements. Under no-action, NOAA Fisheries and the Council could continue to manage fishing activities but would not be specifically required to prevent, mitigate, or minimize adverse impacts on fish habitat to the degree practicable.

4.1.1.2.1.2 Fishery resources not under FMPs

Describing and identifying EFH will have no direct positive or negative impact on other fishery resources in the Gulf of Mexico. The intent of the EFH requirements, to benefit fish through improved habitat protection, may equally benefit non-Federally managed species and important prey species, since these species utilize the same habitats. Thus indirectly, there may be potential improvements to habitat protection and potential benefits to these populations of fish that will occur in the future. Non-Federally managed species and all prey species use the same habitats as managed species (described in Sections 3.2.5). To the degree that consultations or minimization of adverse fishing impacts reduces damage to or enhances habitat used by non-FMP species, these species will benefit from improved habitat. However, it is not possible to measure the level of potential improvement.

Nine non-FMP species of nearshore fish and shellfish make up the majority of commercial and recreational harvest managed in state waters. Consultations are not required for fisheries activities that occur in state waters (that may adversely impact EFH), if those activities do not require Federal licenses, permits, or funding.

4.1.1.2.2 Marine mammals and protected species (ESA)

No direct or significant indirect positive or negative impacts to marine mammals, sea turtles, sea birds and other protected species are anticipated as a result of EFH designation resulting from alternatives developed under Concepts 2, 4, 5, or 6. The protections afforded marine mammals, sea turtles, sea birds and other protected species under the Marine Mammal Protection Act and Endangered Species Act are much more stringent and enforceable, prohibit 'take,' and include protections for habitat used by these species that are more protective than those provided under EFH regulations.

Indirectly, to the degree that consultations or minimization of adverse fishing impacts reduces damage to or enhances habitat used by protected species, these species will benefit from improved habitat. However, it is not possible to measure the level of potential improvement.

4.1.2 Consequences for the human environment

4.1.2.1 Fisheries and fishing communities

None of the EFH alternatives will have any direct effects on the fishing communities of the Gulf of Mexico. The indirect consequence of describing and identifying EFH is that all fishing activities that adversely impact EFH must be identified and alternatives to prevent, mitigate or minimize these impacts must be reviewed and considered by the Gulf Council and NOAA Fisheries.

In anticipation of the designation of EFH through this EIS, six alternatives to prevent, mitigate or minimize fishing impacts have been developed and are compared and contrasted under section 4.3

4.1.2.2 Other affected components of the human environment

No direct positive or negative impacts to components of the human environment will occur as a result of any of the alternatives developed under the EFH Concepts. However, there may be indirect effects as a result EFH designation, and any Federal action that may adversely affect EFH triggers more strict consultative review and/or conservation recommendations under Sections 305(b)(2)-(4) of the M-S Act. Federal actions include permitting processes; applicants who might wish to engage in a development activity that requires Federal licenses, permits, or funding might include private individuals, businesses and industry, state agencies and local governments.

In section 4.1.1.1, the comparisons of the indirect impacts resulting from the EFH concepts and alternatives for each FMP, discuss the changes in the total area of the Gulf that would be identified as EFH. All Federal activities enter the consultative process with NOAA Fisheries if there are impacts to the marine environment. Those actions that might occur in EFH will receive a more thorough review. Depending upon the EFH conservation recommendations of NOAA Fisheries, Federal agencies might request information from applicants for permits, licenses, or funding to assist the agency in completing the EFH consultation. Thus there may be an added burden to applicants beyond current permitting processes. However, there has not been any measure of this potential added burden to the public from current EFH designations (the entire Gulf EEZ) that resulted through the 1998 Generic Amendment.

4.1.3 Consequences for the administrative environment

4.1.3.1 Federal acts

No direct positive or negative impacts to components of the administrative environment will occur as a result of any of the alternatives developed under the EFH Concepts. However, there will be indirect effects as a result of other provisions of the M-S Act. Under Section 305(b)(2) of the M-S Act, each Federal agency must consult with NOAA Fisheries regarding any action authorized, funded, or undertaken by the agency that may adversely affect EFH, and Federal agencies are required to prepare EFH Assessments as part of the consultation process (50 CFR 600.920(e)). Under Section 305(b)(4)(A) of the Act, NOAA Fisheries must provide EFH Conservation Recommendations to Federal and state agencies regarding any action that would adversely affect EFH. Under Section 305(b)(3) of the Act, Councils may comment on and make recommendations to Federal and state agencies regarding any action that may affect the habitat, including EFH, of a fishery resource under Council authority. EFH designations will be reviewed and possibly revised by the Council and NOAA Fisheries every five years.

Where EFH consultations might occur as a result of designation of EFH, they will be the same to those discussed in section 4.1.1.1, which compares the spatial extent of the Gulf that would be identified as EFH resulting from the various EFH concepts and alternatives for each FMP.

Federal agencies will incur costs as a result of conducting EFH consultations, since time and resources will be required to develop EFH Assessments, exchange correspondence, and engage in other coordination activities required for effective interagency consultation. In some cases, Federal agencies might also request information from applicants for permits, licenses, or funding to assist the agency in completing EFH consultation. However, the EFH regulations encourage agencies to combine EFH consultations with existing environmental review procedures to promote efficiency and avoid duplication of effort. Agreements to streamline the EFH consultation process have been developed for key Federal agencies having responsibility in the Gulf of Mexico. Under the appropriate circumstances, administrative costs may be reduced by using "abbreviated consultations" (50 CFR 600.920 (h)). An "abbreviated consultation" is generally applied to Federal actions that do not qualify for a general concurrence, but that are not likely to have substantial adverse impacts on EFH. State agencies and other non-Federal entities are not required to consult with NOAA Fisheries regarding the effects of their actions on EFH, if those activities do not require Federal licenses, permits, or funding.

At this time, there has not been any measure of this potential added burden to the agencies or public from current EFH designations (the entire Gulf EEZ, Concept 2) that resulted through the 1998 Generic Amendment. NOAA Fisheries has examined the question, but has been unable to document a significant change in the number of reviews or the quality of recommendations. Since the 1998 Generic Amendment designated essentially all marine habitat as EFH, it is unlikely that any of the EFH alternatives presented in this EIS will increase the burden to the agencies or the public beyond that already existing. The experience in the region is that consultations have been incorporated into already required documents (notices, EAs, etc.) and employ information already required as part of project review under other existing authorities. Any added time or cost is so minimal that it cannot be quantified with any level of confidence.

For all FMPs and under all EFH alternatives, NOAA Fisheries staff will continue to review and respond to project applications or proposals for work in waters of the Gulf of Mexico. For other than the No Action alternative for EFH, NOAA Fisheries would provide through this EIS as well as FMP Amendments habitat utilization information and maps of habitats for applicants to use in developing applications, and for reviewing potential impacts, in case of consultations resulting from potential adverse impacts to EFH.

NOAA Fisheries and the Council staffs could become more involved in consultations with other Federal agencies with responsibility for non-fishing activities with potential to adversely affect EFH. The Southeast Region of NOAA Fisheries has received and commented on 47,432 permit proposals for the Gulf of Mexico from 1982 to 2001, averaging 2,372 per year (± 598) (Table 3.4.1; Southeast Regional Office, personal communication). As discussed in Section 3.4.1.6.5, there were no discernable trends in the number of consultations that ensue each year, either before or since the 1996 M-S Act reauthorization or the 1998 Generic Amendment. Whether additional consultations will occur as a result of designating EFH cannot be determined.

In addition to Federal resources used in the consultation process, the Gulf Council and NOAA Fisheries will generically amend all FMPs together or the seven FMPs separately, if the Gulf Council and NOAA Fisheries choose alternatives under Concepts 1, 4, 5, or 6. Choosing alternatives under Concept 2 will not require EFH amendments. Administrative costs to the Gulf Council and NOAA Fisheries are reduced by about one-quarter through a Generic Amendment process, rather than amending each FMP individually. Examples of recent administrative costs for documents prepared by the Southeast Region of NOAA Fisheries and various US Fishery Management Councils are: Gulf of Mexico Council's Sustainable Fisheries Act Generic Amendment at $35,000 in Council costs and $22,000 in NOAA Fisheries costs, and the Dolphin/Wahoo FMP shared by 4 Councils at $248,000 in Council costs and $50,000 in NMFS costs. The Gulf Council and NOAA Fisheries would normally need approximately 1.5 to 2 years to amend the Generic Amendment, and longer to amend each of the FMPs separately. However, after the issuance of a Record of Decision (ROD), if amendments are required, a court-ordered schedule directs amending the FMPs by December 26, 2005. This document contains the analysis needed to prepare an amendment, which will reduce the time necessary to implement an amendment to an FMP.

If the Gulf Council adopted the EFH alternative under Concept 1 (No Action), it would not be able to establish HAPCs under the EFH provisions of the M-S Act, because HAPCs are a subset of EFH. Nor would the Gulf Council be able to address preventing, mitigating, or minimizing the adverse effects of fishing on EFH.

4.1.3.2 State and local

Describing and identifying EFH will have no direct impact on state regulatory actions, fishery management, or local regulatory actions. State and local agencies and other non-Federal entities are not required to consult with NOAA Fisheries regarding the effects of their actions on EFH. If an action that a state or local agency wishes to engage in requires a Federal license, permit, or funding then the permitting/funding agency is required to consult NOAA Fisheries if the action may impact areas designated as EFH.

The states or local agencies could use EFH designation for decisions or policies related to fish habitat in state waters. The states could also apply EFH reviews in concert with Federal review, either on a case-by-case basis or through a more formal arrangement, such as a Memorandum of Understanding. Federal Consistency review under the CZMA may be required under Concepts 2, 4, 5, and 6.

Under Concept 1, current State habitat conservation efforts would continue without the potential benefit of EFH designation.

Since the largest possible designation for EFH occurs under Concept 2, status quo, there would not be any significant increase in the level of effort for agency reviews and comment in conjunction with Federal agencies if Concept 4 was selected, since EFH designation under this Concept is not as extensive as under Concept 2.

Conversely, if Concept 5 or Concept 6 were chosen for an individual FMP, there would be some state waters for which no areas of EFH would be designated for that FMP. The level of effort for agency review with respect to EFH in these cases would be less. The following table outlines which states would or would not have EFH designations for specific FMPs.

Managed species		State waters *with* EFH designations for these alternatives	State water *without* EFH designations for these alternatives
Alternative 5	Red Drum	LA, MS, FL	TX, AL
	Reef Fish	FL	TX, LA, MS, AL
	Coastal Migratory Pelagics	LA, MS, AL, FL	TX
	Shrimp	TX, LA, MS, AL, FL	
	Stone Crab	FL	TX, LA, MS, AL
	Spiny Lobster	FL	TX, LA, MS, AL
Alternative 6	Red Drum	TX, LA, MS, AL, FL	
	Reef Fish	TX, LA, MS, AL, FL	
	Coastal Migratory Pelagics	TX, LA, MS, AL, FL	
	Shrimp	TX, LA, MS, AL, FL	
	Stone Crab	TX, LA, MS, AL, FL	
	Spiny Lobster	FL	TX, LA, MS, AL
	Coral	FL	TX, LA, MS, AL

4.1.4 Cumulative impacts

The cumulative effects of designation of EFH may have incremental impacts when considered in conjunction with all past, present, and foreseeable future impacts of designation of HAPC alternatives, designation of habitat areas through other fishery management actions, or by other agencies regulating activities in the marine environment.

Existing protection of habitat occurs now under fishery management actions, in reserves created by actions under sanctuary and national park management plans, and through regulatory actions governing activities such as underwater pipelines, cables, oil rigs and so forth. Consultations that would be triggered by designation of EFH would be in addition to current consultation called for under a variety of statutes as described in Section 3.4.1. Designation of EFH and the ensuing consultations and potential action could add to the areas protected and could incur additional limitations on activities in the marine environment. Designation of HAPCs and the cumulative effects of that action are discussed in detail in Section 4.2.

4.2 Alternatives to identify Habitat Areas of Particular Concern

HAPC can only be chosen as a subset of the areas described and identified as EFH, and like EFH, there are no direct environmental or physical impacts caused by the designation of HAPC. HAPC designation may result in indirect impacts beyond those associated with EFH identification because resource managers and regulators may prioritize conservation of habitat inside HAPCs higher than the rest of EFH. NOAA Fisheries and the Council use HAPCs to focus conservation and management efforts on particularly valuable and/or vulnerable subsets of EFH. Although HAPC designation does not automatically convey any higher regulatory standards for addressing adverse effects of fishing or conducting EFH consultations, NOAA Fisheries and the Council may apply more scrutiny to fishing and non-fishing activities occurring in HAPCs as compared to EFH. NOAA Fisheries and the Council may be more risk averse when developing management measures for HAPCs and when recommending measures to Federal and state agencies.

The potential direct environmental and socioeconomic impacts from management measures to protect HAPCs would be similar to those described for EFH. As with EFH, conservation of HAPCs is expected to support healthier fish stocks and more productive fisheries over the long term, with associated environmental and socioeconomic benefits. However, the indirect impacts will vary among alternatives.

The justifications and rationales for identifying HAPCs cut across FMPs and each of the HAPC alternatives has consequences for more than one FMP. However, because in practice HAPCs will be established under one or other of the FMPs (as a subset of EFH), each HAPC alternative was aligned with the FMP that is most likely to be used for this purpose. The lack of direct impacts of HAPC alternatives leads to similar consequences across FMPs. This section will initially address consequences of each HAPC alternative that apply to all FMPs, and will consider consequences specific to FMPs as appropriate.

The designations of HAPC are expected to provide greater protections indirectly for fish habitats through additional review required in existing regulatory processes. No direct negative effects on the environment are anticipated. Indirect effects of the designation may include protection of habitat through changes in fishery management including modifications to fishing practices, e.g. gear modifications, area restrictions, and in the future, harvest limits, license and permit limitations, etc. These actions are addressed under section 4.3 *Consequences of alternatives for preventing, mitigating, or minimizing the adverse effects of fishing.*

4.2.1 Consequences for the physical and biological environment

4.2.1.1 Consequences for the geological features and marine habitats

The designations of HAPC by FMP are expected to provide greater protections for fish habitats indirectly through review that is additional to that required in existing regulatory processes. As with EFH, none of the HAPC alternatives will have any direct effects on the general bathymetry; geological configuration; water parameters such as temperature, salinity, chemical composition or any other physical components of the Gulf of Mexico. Additionally, designation of HAPC through any of the proposed alternatives will not have any indirect impacts on the oceanographic features of the Gulf of Mexico. However, there will be indirect effects as a result of the other provisions of the M-S Act. Federal agency actions that may adversely affect HAPC, trigger consultation and/or conservation recommendations and alternatives to prevent, mitigate and minimize adverse fishing impacts on EFH/HAPC, must be considered. These are presented in Section 2.5 and their consequences on the physical environment are presented in Section 4.3.

Similarly, none of the HAPC alternatives will have any direct effects on the estuarine, nearshore or offshore habitats that are part of the biological environment of the Gulf of Mexico (described in detail in Sections 3.2.1 and 3.2.2) and are utilized by fishery resources (Sections 3.2.4). The consequences on marine habitats are identical to those for the geological component of the physical environment thus these will be presented together.

Adverse impacts have occurred on geological structures and marine habitats used by many fishes. Describing and identifying HAPC will not by itself restore degraded habitat, but resulting consultations may help to arrest the current degradation and prevent future adverse impacts of non-fishing activities. This may allow the habitat to begin a recovery from past impacts, if it has not been replaced by another habitat type or destroyed. The effectiveness of consultations on mitigating potential adverse impacts will likely depend on the level at which a managed fish species depends on the habitats at risk; however, uncertainty of the role that specific habitat plays in fish production limits the conclusions one may draw on the effects of designating HAPC. The Gulf Council and NOAA Fisheries can currently regulate fishing activities that have potential to adversely impact EFH, but designation of HAPC will help to focus additional attention in this area.

Non-fishing activities that have and continue to adversely affect geological structure and marine habitats include dredging, scraping, sand and mineral mining, oil and gas exploration (drilling), laying pipelines, modifying deposition, and coastal development. Some of these actions could homogenize the seabed surface, cause sedimentation to cover surface features, cause subsidence through removal of oil or gas, or form barriers to river-transported sediments (Section 3.5.3). Other activities that affect marine habitats include dumping and release of contaminants. In some cases, the impacts of non-fishing activities on HAPC occur in areas removed from the location where the activity takes place. For example, rivers may transport high levels of suspended sediments that travel long distances to the marine environment.

Regardless of which HAPC concepts or alternatives are determined to be preferred, environmental sites of special interest, such as the Tortugas Ecological Reserves, Flower Garden Banks HAPC, Florida Middle Grounds HAPC, Shrimp Sanctuary, Cooperative Texas Shrimp Closure, Southwest Florida Seasonal closure, Central Florida Shrimp/Stone Crab Separation Zones, and others will retain existing protections from adverse fishing activities, as well as any additional general protections from non-fishing and other fishing impacts that are provided by the designation of HAPC.

The following sections discuss the potential indirect effects that the different HAPC alternatives may have on the geological component of the physical environment and all marine habitats.

4.2.1.1.1 Alternative 1: (No action) Do not establish any habitat areas of particular concern (HAPC) under the EFH Amendment.

No direct positive or negative impacts to geological features or marine habitats will occur as a result of the Alternative 1. Designation of HAPCs are not required under the reauthorization of the M-S Act, but are highly recommended through regulation to help focus additional attention to particular areas of EFH that may be stressed, sensitive, rare, or ecologically important. If there are no HAPC designations, there would not be any higher level of scrutiny for any particular consultation process. There would be no impacts on fishing activities different than those resulting from EFH designation.

4.2.1.1.2 Alternative 2: (Status quo) HAPC are those that are listed in the 1998 Generic EFH Amendment; no additional HAPC are identified.

The 1998 Generic Amendment defined HAPC as general areas of habitat including nearshore areas of intertidal and estuarine habitats, offshore areas with substrates of high habitat value and diversity or vertical relief which serve as cover for fish and shellfish, and marine and estuarine habitats used for migration, spawning, and rearing of fish and shellfish (Generic Amendment, 1998). In addition, some specific sites were designated as HAPC including Florida Keys Marine Sanctuary, Flower Garden Banks National Marine Sanctuary, Apalachicola National Estuarine Research Reserve, Rookery Bay National Estuarine Research Reserve, Weeks Bay National Estuarine Research Reserve, Grand Bay (Mississipi), Florida Middle Grounds, and the Dry Tortugas (Fort Jefferson National Monument).

No direct positive or negative impacts to geological features or marine habitats will occur as a result of Alternatives 2. Indirect effects are the same as those described under EFH, except that a higher level of scrutiny is justified for HAPC during conservation consultations. Comments generated through the consultation process should be based on the importance of the HAPC habitats to fish managed under the seven FMPs, and would be expected to provide some level of protection to the geological features and Gulf fish habitats. However, since such a broad area of EFH was designated as HAPC, there is no significant difference in the consultation process outside of the specific sites listed above.

4.2.1.1.3 Alternative 3: HAPCs consist of all the existing Federally-managed marine areas. These include two National Marine Sanctuaries, four National Estuarine Research Reserves, 31 National Wildlife Refuges, seven National Marine Fisheries Service Critical Habitat Areas Fisheries Management Zones, and three National Park Systems, as listed in Table 2.4.2.

No direct positive or negative impacts to geological features or marine habitats will occur as a result of Alternative 3. Indirect effects are the same as those described under EFH, except that a higher level of scrutiny is justified for HAPC during conservation consultations for activities that may occur within the 47 Federally managed sites specified. Comments generated through the consultation process would be based on the importance of the HAPC habitats to fish managed under the seven FMPs, and would be expected to provide some incremental increase in protection to the geological features and Gulf fish habitats.

Some of the areas selected as HAPC under Alternative 3 were designated under the 1998 Generic Amendment. Under Alternative 3 a greater number of specific locations would be designated HAPC than under the 1998 Generic Amendment, which would result in more areas receiving a higher level of scrutiny.

However, it is recommended in the regulations that HAPC be discrete areas of habitat with justifiable reasons for being chosen. Some of the proposed sites cover a number of habitat types and are relatively large, and thus may not meet the intent of the regulation, and may not be suitable as HAPC. Additionally, many of the NWRs on this list do not appear to be stressed, have very sensitive or rare habitat.

4.2.2 Alternative 4: Identify and establish habitat areas of particular concern as those habitat areas used for spawning aggregations of managed reef fish species that are most in need of protection.

No direct positive or negative impacts to geological features or marine habitats will occur as a result of implementing Alternative 4. Indirect effects are the same as those described under EFH, except that a higher level of scrutiny is justified for HAPC during conservation consultations for activities that may occur within reef fish spawning sites that get specified. If all the sites proposed through the 1999 Reef Fish Regulatory Amendment were to be established as HAPC, the combined area would total 2,157 nm^2 in the Gulf of Mexico.

In contrast to the sites listed under Alternative 2 or 3, any sites identified under Alternative 4 will be clearly linked to providing an "important ecological function" (i.e. spawning), one of the four HAPC considerations. Therefore, each site would be discrete, and readily defensible as a HAPC.

4.2.2.1.1 Alternative 8: HAPC are identified as habitat parcels that meet one or more of the considerations set out in the EFH Final Rule (50 CFR, Part 600).

No direct positive or negative impacts to geological features or marine habitats will occur as a result of Alternative 8. Indirect effects are the same as those described under EFH, except that a higher level of scrutiny is justified for HAPC during conservation consultations for activities that may occur within the 21 Federally managed sites specified.

In contrast to the sites listed under Alternative 2 or 3, the 21 sites identified under Alternative 8 are clearly linked to one or more of the four HAPC considerations, and several meet three of the four considerations. These sites had one or more of the following for one or more FMP: high habitat use index, high fishing sensitivity index, high non-fishing sensitivity index, high habitat stress index, or high rarity index. Each site is discrete, and is readily defensible as an HAPC.

4.2.2.1.2 Alternative 9: The following areas are identified as HAPCs: the Flower Garden Banks, Florida Middle Grounds, Tortugas North and South Ecological Reserves, Madison-Swanson Marine Reserve, Pulley Ridge and the following reefs and banks of the Northwestern Gulf of Mexico: Stetson, McNeil, Bright Rezak, Geyer, Mcgrail Bouma, Sonnier, Alderice and Jakkula (Preferred Alternative)

No direct positive or negative impacts to geological features or marine habitats will occur as a result of Alternative 9. Indirect effects are the same as those described under EFH, except that a higher level of scrutiny is justified for HAPC during conservation consultations for activities that may occur within the four sites specified.

Three of the sites identified are contained in the 21 sites identified under Alternative 8 (Flower Gardens, Florida Middle Grounds, and Tortugas Ecological Reserves) and are clearly linked to three of the four HAPC considerations. These sites had the following for one or more FMP: high habitat use index, high fishing sensitivity index, high non-fishing sensitivity index (Tortugas Ecological Reserves only), and high rarity index. Each site is discrete, and is readily defensible as an HAPC. Although Madison-Swanson did not rank high for ecological importance for many species, the Council chose to include it due to the ecological importance of the habitat to several grouper species, in particular gag, which has been well documented (Sections 3.2.4.2.2.7 and 3.5.1.7). Pulley Ridge is very unique and under current study as potentially the deepest coral reef in the U.S. (Section 3.2.2.1), however for the purposes of the EIS are classified as living hard bottom. Due to its unusual benthic productivity, considering its depth of between 60 and 70 m, the Council chose to include it as an HAPC. Hermatypic corals and photosynthetic organisms on the ridge survive on only 1-2% of the available surface light. Likewise, new research underway at the eight named shelf-edge and mid-shelf reefs and banks in the northwestern Gulf of Mexico is identifying these areas as having significant coral resources. The research has been undertaken to understand the linkages and connectivity of what is considered a unique system of biological communities. Throughout the Gulf, coral resources are considered rare and worthy of HAPC designation.

As the Council's Preferred Alternative for HAPC, these identified sites were taken into special consideration with respect to preventing, mitigating, or minimizing adverse fishing actions (Section 4.3). By implementing the proposed actions under the Preferred Alternative for modifying fishing activities, these sites will have a greater level of protection from adverse fishing activities. Over time, the elimination of these environmentally damaging fishing activities should result in incremental improvements and restoration from past impacts.

4.2.2.2 Consequences for the fishery resources and marine mammals

The consequences for the fishery resources and marine mammals of the biological environment will be the same as those described in Section 4.1.1.2, except that through the designation of HAPC and the anticipated higher level of scrutiny during consultations, HAPC will hopefully be provided extra protection from both adverse fishing and non-fishing impacts. This in turn should provide those species that utilize these areas additional protection from adverse impacts and support the ecological functions that these areas provide.

The Preferred Alternative 9 will have particular significance for reef fish and coral. At least two of the four identified sites, the Flower Gardens and Tortugas Ecological Reserves, are ecologically important to reef fish, and also contain rare, live coral reefs; other reef and banks in the northwestern Gulf are also being shown to have important coral resources. Added protection through HAPC designation will help to support and maintain the coral resources of the Gulf of Mexico and all the species that it supports. Added protection for the Florida Middle Grounds will also provide benefits for non-reef building species of hard and soft corals. As a known and well documented spawning site for gag and other grouper species, identifying Madison-Swanson as HAPC will specifically protect this ecological function for these species, and will thus support these fishery resources.

4.2.3 Consequences for the human environment

4.2.3.1 Fisheries and fishing communities

None of the HAPC alternatives will have any direct effects on the fishing communities of the Gulf of Mexico. The indirect consequence of describing and identifying HAPC is that all fishing activities that adversely impact HAPC must be identified and alternatives to prevent, mitigate or minimize these impacts must be reviewed and considered by the Gulf Council and NOAA Fisheries, as with any EFH.

In anticipation of the designation of EFH and HAPC through this EIS, six alternatives for preventing, mitigating, or minimizing adverse impacts to EFH have been developed and are compared and contrasted under Section 4.3. Among these alternatives, the Preferred Alternative does have two actions that specifically link fishing activities with habitats in HAPC. The impacts of these actions are discussed in Section 4.3.

4.2.3.2 Other affected components of the human environment

No direct positive or negative impacts to other components of the human environment will occur as a result of any of the HAPC alternatives. The indirect impacts will be identical to those described under 4.1.2.2, however, those actions that might occur in HAPC will receive a more thorough review. Depending upon the HAPC conservation recommendations of NOAA Fisheries, Federal agencies might request information from applicants for permits, licenses, or funding to assist the agency in completing the EFH/HAPC consultation. Thus there may be an added burden to applicants beyond current permitting processes. However, there has not been any measure of this potential added burden to the public from current HAPC designations (the entire Gulf EEZ) that resulted through the 1998 Generic Amendment.

4.2.4 Consequences for the Administrative Environment

The consequences for the Administrative Environment will be the same as those described in Section 4.1.3, except that designation of HAPCs is expected to encourage a higher level of scrutiny for conservation, will hopefully afford these habitats extra protection, and give fish species that utilize these areas an extra buffer against adverse impacts. HAPC designations will be reviewed by the Council and NOAA Fisheries every five years.

4.2.5 Cumulative impacts

When the designation of HAPC is added to identification of EFH as well as all past, present, and foreseeable future impacts arising from designation of marine protected areas such as existing HAPCs, parks, marine sanctuaries and no-take zones the cumulative impacts include incremental indirect benefits in habitat protection as well as incremental restrictions on uses of the marine environment for both fishing and non-fishing activities. Cumulative impacts of HAPCs include additional administrative, enforcement and monitoring requirements for the managing agencies.

4.3 Consequences of alternatives for preventing, mitigating, or minimizing fishing impacts

4.3.1 Practicability Factors

This EIS uses specific practicability factors relevant to the EFH Final Rule requirements to evaluate if the action is reasonable and capable of being done in light of available technology and economic considerations, and will not impose an unreasonable burden on the fishers, as described in Section 2.1.6.3.3. The practicability factors used for the Gulf of Mexico are discussed in the relevant consequence sections as follows, and summarized in the cumulative impacts section (Section 4.3.8):

Practicability Factor	Description	Consequence Section
Changes in EFH	Future improvement or degradation in the extent, quality and/or function of EFH resulting from fishing impacts alternatives	Geological features and marine habitats
Population effects on FMU species from changes in EFH	Magnitude and direction of productivity changes resulting from changes in EFH	Federally managed fish
Ecosystem changes from changes in EFH	Improvement or degradation of ecosystem function resulting from changes in EFH	Non-Federally managed fish, marine mammals and protected species
Net economic change to fishers	Changes in short-term and long-term economic conditions of fishers as a result of fishing impacts alternatives	Human environment
Equity of potential costs among communities	Equity around the region, in relation to short-term and long-term economic conditions of fishermen as a result of fishing impacts alternatives	Human environment
Effects on enforcement, management, and administration	Changes in requirements or effectiveness of enforcement, management, and administration as a result of fishing impacts alternatives	Administrative environment

4.3.2 Consequences for geological features and marine habitats

4.3.2.1 Alternative 1 (No Action/Status Quo)

Alternative 1. (No Action/Status Quo): Use existing regulations to prevent, mitigate, or minimize adverse fishing impacts in State and Federal waters of the Gulf of Mexico.

Alternative 1 is the status quo alternative. The physical environment of the benthic offshore Gulf of Mexico environment ranges from open sand and mud areas to areas of fragile geological and biological formations (i.e. corals), as discussed in Section 3.2. Potential impacts to these habitats from different fishing gears are presented in detail in Section 3.5.2, description of existing fisheries is in Section 3.3.1, and existing regulations enacted by the Gulf Council and NOAA Fisheries that currently protect many habitats, and especially the most fragile or sensitive (coral) are presented in Section 3.4.1.2.2. Alternative 1 would however, provide no additional protection for those coral areas outside of these protected areas. Other sensitive habitats including hard bottoms and SAV would not receive additional protection either.

Many types of identified habitats are currently protected by fishing area closures and gear restrictions established by the Gulf Council and NOAA Fisheries management to protect habitat or as an ancillary benefit of management measures designed for other purposes. The Tortugas North and South Marine Reserves are no-take marine reserves and protect 185 square nautical miles. Much of the reserve is coral reef and areas identified as important spawning sites for black, red, gag, Nassau, and yellowfin grouper; scamp and hinds (Ault, *et al*. 1998); and gray, mutton, cubera, yellowtail, and dog snapper.

Regulations in the Coral Reef FMP since 1984 prevent the use of gear interfacing with the bottom in the Flower Garden Banks HAPC and the Florida Middle Grounds HAPC; both areas have extensive live and hard bottom areas. Use of bottom longline, bottom trawl, dredge, pot or trap is prohibited year round. Fishing over these areas (trolling, pelagic longlines) or by vertical gear, spears or powerheads, is not banned; the latter three gears are considered to potentially have minor impacts in coral reef areas (See Section 3.5.2.1).

A variety of habitats in the Tortugas Shrimp Sanctuary (hard bottom, sand/shell, soft bottoms, sea grasses) are protected from all trawl fishing, and the vast area of the Gulf inside the Longline and Buoy Gear Restricted Area are protected from use of bottom longlines, fish traps, and fishing with powerheads.

In summary, while coral reef and siltstone or clay stone banks can be damaged by snagging or contact with bottom fishing gear such as trawls, doors, bottom longlines, traps and pots, these gears are seldom used on coral reefs due to existing fishing restrictions. Shrimp trawling in the Gulf is heaviest off of Texas and Louisiana compared to the rest of the Gulf (Figures 3.3.8, 3.5.23a,b) with sometimes as many 4,100 - 22,400 days fished by NMFS statistical area. However, this fishing is predominantly over bottom identified as clay, silt or sand. All known coral areas are closed to trawling activities. There is some shrimp fishing on hard bottom off Florida, but effort is much less, averaging 80 days the last two years. Longline gear is predominantly used on the west Florida shelf over hard bottom, sand and silt outside of 20 fathoms, and in the western part of the Gulf over a mixture of habitats including the pinnacle region, outside of 50 fathoms. Relative impacts are greatest on all habitats off the coast of Florida north of Naples (Figure 3.5.18b). Use of towed gear in SAV or hard bottom communities with vertical structure can lead to damage, removal of biogenic components, erosion and turbidity problems. Traps/pots set on coral and hard bottom can also cause breakage or substantial damage. Current fish trap use only negatively impacts hard bottom (Figure. 3.5.19). Static gears can have an impact coral reef and hard bottom habitats, as vertical lines and hooks and bottom longlines can snag and topple coral heads and uproot sessile invertebrates, and lost gear can accumulate on the bottom and have a fouling and smothering effect if substantial amounts collect there. Coral breakage from spears and powerheads can occur, especially for branching coral and soft bodied sessile invertebrates. Overall, the impacts from vertical gears, spears and powerheads on the physical environment are generally minor, however relative impacts on hard bottom are greatest in the eastern Gulf from Venice, FL north, and Florida Bay to the Keys (Figures 3.5.17b, 3.5.20, 3.5.21).

With respect to practicability factor, 'changes to EFH,' any ongoing trends in damage to geological features and marine habitats from fishing gears would continue, barring other external factors. If the habitat damage leads to reductions in abundance for any species, that decline would also continue. Available information does not provide conclusive evidence that any managed species are currently habitat limited, however habitat limitation could occur, but go undetected. It is also not clear how much habitat damage has occurred from adverse impacts of fishing. The few studies that have been conducted are presented in Section 3.5.2. There has not been extensive research due to the scope and scale of the fishable areas in the Gulf of Mexico; such research takes many years and millions of dollars to conduct.

Areas most likely to be adversely affected include hard bottoms of the West Florida Shelf, Florida Bay, and banks along the outer continental shelf from Mississippi to Texas. The additional benefits of fishing management beyond status quo protection, as listed under the other alternatives, would not be gained with Alternative 1.

4.3.2.2 Alternative 2

Alternative 2: Establish minor modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- No bottom trawling over coral reefs
- Require aluminum doors on trawls
- Limit bottom longline sets to 6 miles in length, limited to three sets/day on hard bottom
- Require circle hooks on all vertical lines and allow maximum sinker weights of 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs, and handlines
- Require use of buoys on all anchors

Prohibition of bottom trawling over coral reefs would have significant positive impacts on the small coral areas that are not currently protected through other fishery management protections. However, since *most* areas of coral habitat are already protected from trawling activities, the overall improvement for coral habitat in the Gulf of Mexico would be minimal. Some deepwater areas of coral that are just being identified, such as Pulley Ridge on the southern edge of the West Florida Shelf (Section 3.2.2.1) could benefit from such prohibition in the future.

Bottom longline gear has the potential to cause moderate adverse impacts to coral and hard bottom habitats (See Sections 2.5.3 and 3.5.2.1.6) depending upon how it is deployed, and sea state conditions, particularly hard bottoms since longlining primarily occurs on this habitat (Figures 3.3.3; 3.5.18a, b). Setting a limit on the length and number of sets per day near the average should reduce potential impacts by approximately 24% if fishers currently make three sets per day. This would reduce pulling, tearing, and breaking of soft and hard branching corals, and other hard bottom organisms. Similar restrictions could be established by NOAA Fisheries for bottom longline fishing for sharks. What the total benefit of this action would be for habitats is not quantifiable, but any benefit would require that this actually limited effort over hard bottom, and that it was not simply displaced to other regions or habitats.

The potential environmental benefit of requiring aluminum doors for trawls is positive but minor. The use of circle hooks may be expected to have a small positive effect since circle hooks tend to limit gear from snagging bottom features when used with vertical gear. Limiting the amount of weights and sinkers used with vertical will have a positive environmental benefit. The action of weights hitting the bottom with each line fished will cause damage to biogenic structures, and over time can be relatively significant. Vertical gear is fished over hard bottom more than other types of bottoms, and the relative impacts are highest on this bottom type. However, data are lacking to know how much weight is used on average, and even to know what the complete range of weights used is. Data on fishing effort, such as collected by log book for commercial fishermen or through the MRFSS does not request information on amount of weight usually used. Additionally neither ask how many times did the fishing line get dropped to the bottom, which would be a measure of how often weights from vertical gear come into contact with the bottom. Due to the nature of this type of fishing, this would be a very onerous and costly data collection task, and would require an observer on the vessel to record (for commercial or recreational).

The benefits of the anchor buoy system will have positive environmental benefits, however to what extent is unknown. Similar to weights on fishing line, there is no way to quantify the total number of recreational and commercial boat or vessel trips in the Gulf of Mexico that require anchoring, nor the number of times anchors hit the bottom.

With respect to practicability factor, 'changes to EFH,' these actions would have some environmental benefits to coral reefs, hard bottoms and SAV. In particular, the most potentially devastating impact, trawling on coral, would be eliminated. The extent of the combined benefits is unknown, particularly since it is not clear, nor quantifiable, as to how much damage has occurred from these adverse impacts of fishing.

4.3.2.3 Alternative 3

Alternative 3: Establish moderate modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 2, apply the following action items:

- Limit use of tickler chains to one chain with a maximum ¼ inch link diameter
- Limit total trawl headrope length to 180 feet or less
- Limit trawl vessels to 85 feet or less LOA, and grandfather existing vessels
- Prohibit trotlines when using traps/pots

It is expected that the restrictions in gear type proposed in Alternative 3 would reduce adverse impacts to habitat caused by heavy bottom trawling gear and long lines. Limiting the impact of tickler chains to the use of one single, smaller chain is expected to reduce impacts to hard bottom, SAV and sand/soft sediment habitats. Tickler chain currently used is generally either ¼ inch or 5/16 inch, and sometimes several chains are used in unison to act as one heavier chain , or in sequence about one foot apart ahead of the trawl (John Watson, personal comm.) The ¼ inch chain will still serve the purpose of "tickling" the shrimp off the bottom and into the net, will cause less damage, but whether or not it would affect the yield of the shrimp has not been tested. The use of trawling gear equipped with aluminum doors and single ¼" tickler chains will likely still cause some destruction of sensitive geological formations in hard bottoms and erosion in SAV.

The intent of limiting trawl headrope length and vessel size is to limit the amount of sea bottom swept by trawl nets. This would reduce the adverse impact of the chain and net directly on the bottom. To try to calculate area swept per fishing day, NOAA fisheries estimated that most of the fleet used a headrope length of 180 feet or less. However, some vessels are being built as large as 90- to 100- feet in length, with twin engines, and the capacity to pull four 75-foot nets (total 300 feet of headrope). It is not exactly known how many shrimp vessels fish in the Gulf or what their gear specifications are, thus the total benefit this action may have is unknown. The Economics Office of NOAA Fisheries has recently (2003) begun an effort to survey fishermen to gather this information. However, this action attempts to be precautionary by limiting vessels from getting bigger and having increased impacts per trawl.

The prohibition of trot lines when using pots and traps will limit the amount of gear contacting the bottom, but moderate to minimal adverse impacts to most physical environments caused by the traps and pots themselves, not the trot lines, can still be expected by this action.

With respect to practicability factor, 'changes to EFH,' these actions as one Alternative will have some environmental benefits to coral reefs, hard bottoms, SAV, sand and soft bottoms. Over time, the physical environment created by biological forces should be expected to recover from past impacts that may have been caused by these gears, if these impacts are reduced or eliminated in the future. Because many of the most sensitive geological formations are no longer geologically active, recovery from past impacts is not expected. In light of current patterns of fishing activity and technology, the hard bottom areas most likely benefiting from this alternative would be the West Florida Shelf, including the Florida Middle Grounds, and Pulley Ridge, while sand and soft bottoms throughout the Gulf would receive some benefits.

4.3.2.4 Alternative 4

Alternative 4: Establish major modifications to fishing gears and gear closures on sensitive habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 3, apply the following action items:

- Limit total trawl headrope length to 120 feet or less
- Limit trawl vessels to 81 feet or less LOA on hard bottom or SAV
- Prohibit use of tickler chains on hard bottom
- Prohibit use of all traps/pots and bottom longlines and buoy gear on coral
- Prohibit all use of anchors on coral, and require use of mooring buoys if vessels need to "anchor" or maintain a stationary position

In addition to the possible benefits to habitat described in 4.3.2.3, this Alternative should provide moderate reductions of the adverse impacts from the gears targeted, incrementally more benefit to managed species than Alternative 3. Prohibiting use of all traps, pots, bottom longlines, and anchors on coral reefs will provide positive benefits to this habitat. Since there are not haul-by-haul data for current fishing effort with these gears, how much impacts corals may receive is not known, thus it is not possible to quantify all the potential benefits. Most fishing effort for stone crabs and lobster occurs on hard bottom (Figures 3.3.9, 3.3.10, 3.5.24, 3.5.25); coral reef habitat in the EEZ occurs in areas already closed to pots, traps, and longline-buoy gear. However, some coral areas occur outside the closed areas in the vicinity of the Tortugas (which represent about 1,295 ha or approximately 3200 acres) and potentially in areas west of the Tortugas (Pulley Ridge). Thus the areas most likely to be affected occur on the West Florida Shelf.

Since most shrimp trawling occurs over soft bottom (mud and silt), prohibiting the use of tickler chains on hard bottom, will have limited benefits to habitat. Further restricting vessel size on hard bottom and SAV and headrope in all habitats will reduce the amount of these habitats that are swept by trawl nets, than proposed in Alternative 3, which will reduce the adverse impacts of the chain and net directly on the bottom to a larger area. It is not exactly known how many shrimp vessels fish in the Gulf or what their gear specifications are, thus the total benefit this action may have is unknown, as discussed in Section 4.3.2.1. However, trawling has occurred on sand and soft sediments for many years with no apparent change in productivity of shrimp. If there was a noticeable reduction in harvest in Federal waters due to these actions, effort may shift to state waters causing the overall population to not significantly change.

With respect to practicability factor, 'changes to EFH,' these actions as one Alternative will have the most positive environmental benefits to coral reefs, and some benefits to hard bottoms, SAV, sand and soft bottoms. Over time, the physical environment and habitats should be expected to recover from past impacts that may have been caused by these gears, if these impacts are reduced or eliminated in the future. Because many of the most sensitive geological formations are no longer geologically active, recovery from past impacts is not expected. In light of current patterns of fishing activity and technology, the coral and hard bottom areas most likely benefiting from this alternative would be the West Florida Shelf, including the Florida Middle Grounds, and Pulley Ridge, while sand and soft bottoms throughout the Gulf would receive some benefits.

4.3.2.5 Alternative 5

Alternative 5: Prohibit gears and fishing activities that have adverse impacts on EFH from the EEZ. Apply the following action items:

- Prohibit use of all bottom trawling gear
- Prohibit use of all traps and pots
- Prohibit use of all bottom longline & buoy gear
- Prohibit use of all spears and powerheads
- Prohibit use of all vertical gear
- Prohibit use of all anchors

This alternative would be expected to provide maximum protection of sensitive physical environments and habitats from destructive fishing practices. As this alternative eliminates all potential contact with bottom habitats, it is expected that no adverse impacts to the physical environment would occur. All of the relative fishing impacts, by gear type, depicted in Figures 3.5.17-3.5.26 would be eliminated for all Federal waters.

With respect to practicability factor, 'changes to EFH,' these actions as one Alternative will provide the maximum protection possible, and would allow adversely impacted bottom habitats to recover from past fishing impacts, barring impacts from other external (non-fishing) factors.

4.3.2.6 Alternative 6 (Preferred alternative)

Alternative 6 (Preferred Alternative): Establish minor modifications to fishing gears and a gear closures on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- Regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs
- Prohibit bottom anchoring over coral reefs in HAPCs
- Prohibit use of bottom longlines, buoy gear, and all traps/pots on coral reefs
- Prohibit the use of trawling gear on coral reefs
- Require a weak link in the tickler chain of bottom trawls on all habitats

Alternative 6 (Preferred Alternative) will provide some of the benefits described in Alternative 2 (Section 4.3.2.2; no trawling on coral; regulation of fishing weights over coral) and some of the benefits described in Alternative 4 (Section 4.3.2.4; prohibition of bottom longlines, buoy gear and all traps/pots on coral).

Prohibition of bottom trawling over all coral reefs would have significant positive impacts on the small coral areas that are not currently protected through other fishery management protections. However, since *most* areas of coral habitat are already protected from trawling activities, the overall improvement for coral habitat in the Gulf of Mexico would be minimal. Some deepwater areas of coral that are just being identified, such as Pulley Ridge on the southern edge of the West Florida Shelf (Section 3.2.2.2.1) could benefit from such prohibition in the future.

Prohibiting use of all traps, pots, bottom longlines, and buoy gear on coral reefs will have positive impacts on all coral reef habitat. The environmental benefits are described in Section 4.3.2.4, however, it is not possible to quantify all the potential benefits. Coral reef habitat in the EEZ occurs in areas already closed to pots, traps, and longline-buoy gear. However, some coral areas occur outside the closed areas in the vicinity of the Tortugas (which represent about 1,295 ha or approximately 3200 acres) and potentially in areas west of the Tortugas (parts of Pulley Ridge). Thus the areas most likely to be affected occur on the West Florida Shelf.

Requiring the use of a weak link on tickler chains used with bottom trawls will primarily have positive benefits to hard bottoms that trawls may encounter. The intent is that if the chain were to snag on a piece of hard bottom, the weak link would break and keep the chain and net from dragging and tearing up pieces of bottom life. There would likely still be some damage to hard bottoms, but less than if the chain were sweeping forward over a wide area.

Regulating the amount of weights and sinkers used with vertical gear should have a positive environmental benefit. The action of weights hitting the bottom with each line fished causes damage to biogenic structures, and over time can be relatively significant. Vertical gear is fished over hard bottom more than other types of bottoms, and the relative impacts are highest on this bottom type.

Since data are lacking to know how much weight is used on average by fishermen now, and even to know what the complete range of weights used is, there is no way to assess the potential benefit to habitat from this action at this time. This alternative identifies that this needs to be addressed through future action of the Council.

With respect to practicability factor, 'changes to EFH,' these actions as one Alternative will have the most positive environmental benefits to coral reefs, and some benefits to hard bottoms, SAV, sand and soft bottoms. Over time, the physical environment and habitats should be expected to recover from past impacts that may have been caused by these gears, if these impacts are reduced or eliminated in the future. Because many of the most sensitive geological formations are no longer geologically active, recovery from past impacts is not expected. In light of current patterns of fishing activity and technology, the coral and hard bottom areas most likely benefiting from this alternative would be the West Florida Shelf, including the Florida Middle Grounds, and Pulley Ridge, while sand and soft bottoms throughout the Gulf would receive some benefits.

4.3.2.7 Alternative 7

Alternative 7: Establish some minor modifications to fishing gears and one major gear closure on sensitive live hard bottom habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. The actions include:

- Limit bottom longline sets to 5 miles in length, and to 3 sets/day
- Prohibit trotlines when using traps/pots
- Prohibit all anchoring
- Enact a seasonal closure for shrimp trawl fishing

Bottom longline gear has the potential to cause moderate adverse impacts to coral, but minor impacts to hard bottom habitats (See Sections 2.5.3, 3.5.2.1.6 and Table 3.5.1) depending upon how it is deployed, and sea state conditions. Most of the impact is to the living biota on the hard bottom and not to the geological substrate underneath. Currently, longline fishing does primarily occur on live hard bottom (Figures 3.3.3; 3.5.18a, b), however, since this fishing activity is already restricted to depths greater than 20 or 50 fathoms in the entire Gulf, the substantial hard bottom areas off the west coast of Florida are already protected, thus overall benefit to habitat would likely be minimal.

Since bottom longline sets used to catch reef fish average lengths of 7.81 miles (NOAA Fisheries Logbook data, 1990-2001), setting a limit on the set length to 5 miles should reduce potential impacts by approximately 36% if fishers currently make three sets per day (13% greater reduction than if lines were limited to 6 miles in length, as in Alternatives 2, 3, and 4). If there were not a limit to the number of sets per day, a limit to the total days fished would need to be established to reap any environmental benefit. It has been reported that fishermen prefer to set and retrieve approximately 20 miles of longline per day (B. Spaeth, pers. comm.), and this alternative would allow 15 miles total to be set, approximately 25% less. The benefits to habitat would be a reduction of pulling, tearing, and breaking of soft and hard branching corals, and other sessile hard bottom organisms. The total overall habitat benefit of this action is not quantifiable, but would be if vessels were required to have VMS. Additionally, this action would be more enforceable if this set limitation were required at all times while fishing. Finally, although this action directly benefits live hard bottom, it could indirectly cause increased fishing pressure on sand, silt or clay bottoms, if fishing effort is simply displaced to other regions. However, this would have very minimal impacts to these bottom types.

Pulling along trotlines while using traps can cause dragging of line and the traps along the bottom, actions that can be detrimental to habitat with high relief, such as live hard bottom. The area swept by trotlines during trap recovery can be much greater than the cumulative area of the individual traps themselves. The impacts are similar to those for longline gear. The prohibition of trot lines when using pots and traps will limit the amount of gear contacting the bottom, but moderate to minimal adverse impacts to most physical environments are caused by the traps and pots themselves, not the trot lines, can still be expected by this action.

Anchoring likely causes the most impact from those commercial or recreational fisheries for which anchoring is critical to the fishing operation. These would include fisheries that use hand lines, powerheads and spears, and all other hand harvesting types of fishing. Prohibition of anchoring associated with fishing activities would be expected to provide maximum protection of sensitive physical environments and habitats from anchoring. As this alternative eliminates all potential contact between anchors and bottom habitats, it is expected that no adverse impacts to the physical environment would occur. All of the fishing impacts related to anchoring on live hard bottom would be eliminated for all Federal waters.

Trawling activities can have a moderate impact on hard bottom habitats. Trawl gear is heavy, and constant trawling over any particular area can damage the geological substrate (old coral reef structure, siltstone or clay stone banks, as well as salt domes). However, the largest region of live hard bottom in the Gulf off the west coast of Florida, which is actually a mix of patches of hard bottom-sandy areas, receives predominantly the lowest shrimp fishing pressure, based on shrimp fishing effort data for 2000 and 2001 (Fig. 3.3.8). The statistical areas over this large patchy area averaged less than 81 days fished per year, the lowest category on the scale. Whether this fishing pressure was spread out within the statistical area, or was concentrated on certain parts of the region is impossible to determine, thus quantifying the environmental benefits to habitat are equally difficult to quantify. The total overall habitat benefit of this action could be better estimated if shrimp fishing vessels were required to have VMS, thus allowing better data on effort over particular habitats or regions.

With respect to practicability factor, ‘changes to EFH,’ these actions as one Alternative will have the most positive environmental benefits to hard bottoms, but may cause fishing effort to be displaced to sand and soft bottoms. Over time, the physical environment and habitats should be expected to recover from past impacts that may have been caused by these gears, if these impacts are reduced or eliminated in the future. Because many of the most sensitive geological formations are no longer geologically active, recovery from past impacts is not expected. In light of current patterns of fishing activity and technology, the hard bottom areas most likely benefiting from this alternative would be the West Florida Shelf.

4.3.3 Consequences for Federally managed fish

4.3.3.1 Alternative 1 (No Action/ Status Quo)

Alternative 1. (No Action/ Status Quo) Use existing regulations to prevent, mitigate, or minimize adverse fishing impacts in State and Federal waters of the Gulf of Mexico

As the Status Quo alternative, any trends in ongoing habitat damage from fishing gears would continue, barring other external factors. With respect to practicability factor 'population effects on FMU species from changes to EFH,' over time, habitat damage is expected to lead to some reductions in abundance for managed species, and that decline would continue. Available information does not provide conclusive evidence that any managed species are currently habitat limited. However, habitat limitation could occur, but go undetected. It is also not clear how much habitat damage has occurred from adverse impacts of fishing.

4.3.3.2 Alternative 2

Alternative 2. Establish minor modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- No bottom trawling over coral reefs
- Require aluminum doors on trawls
- Limit bottom longline sets to 6 miles in length, limited to three sets/day on hard bottom
- Require circle hooks on all vertical lines and allow maximum sinker weights of 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs, and handlines
- Require use of buoys on all anchors

Available information does not provide conclusive evidence that any managed species are currently habitat limited. However, habitat limitation could occur, but go undetected. These measures will directly benefit fish and may result in higher productivity if the measures prevent habitat limitation from occurring, or lead to improved habitat. These measures may result in population expansion of some fish species harvested from the Gulf of Mexico.

Bottom trawling on coral could severely damage coral (Table 3.5.1), and could reduce the carrying capacity of fish species that use coral habitat. The amount of trawling on coral should be negligible, as most coral are in areas closed to trawling and shrimp do not occur in high abundance over coral. Closing other areas that might contain coral (i.e. Pulley Ridge) would prevent accidental encounters between coral and trawls, and might have a potentially precautionary benefit to managed species, particularly corals in the Coral FMU. This management measure will likely not affect the catch of fish species. The potential environmental benefit to habitat of requiring aluminum doors for trawls is positive but minor. However, benefits to managed species is likely negligible. This management measure would likely not affect the catch of fish species.

Limiting longline sets to 6-miles and three sets per day will reduce the average amount of line impacting the bottom by about 24% if fishers currently make three sets per day. If fishers begin fishing more days per year, the calculated reduction in bottom impact will decline. Managed species will benefit to the degree that the longline limitation reduces or prevents habitat damage, but it is not possible to directly identify or quantify what the potential benefit to other managed species may be. Any benefit would require that this actually limited effort over hard bottom, and that it was not simply displaced to other regions or habitats. The harvest of species caught by longline would likely decline under this limitation, thus providing other benefits to managed species.

Circle hooks can cause lower hooking mortality than J-hooks in commercial and recreational fisheries. Fished released to the water, because they are out of season, not legal size, or undesirable, should have increased survival. In some fisheries, such as highly migratory recreational fisheries, circle hooks promote conservation by reducing bycatch, increasing catch rates and lowering post-release mortality (NOAA 2003b). The recurved points of circle hooks are less likely to snag, which could reduce entangling and breaking of coral and hard bottom biota. Circle hooks will not eliminate damage caused by fishing sinkers or by entangling line.

An anchor ball anchor retrieval system may reduce habitat damage from anchors dragging on coral, hard bottom, and SAV, but like the other actions above, it is not possible to quantify the potential benefits to managed species, beyond the habitat benefits.

With respect to practicability factor 'population effects on FMU species from changes to EFH,' there should be minor changes in fish abundance if habitats that have been degraded are allowed to recover and subsequently provide improved carrying capacity for managed species. This would most likely affect those species for which hard bottom is ecologically important (Tables 3.2.2, 3.2.6, 3.2.21, 3.2.25).

4.3.3.3 Alternative 3

Alternative 3: Establish moderate modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 2, apply the following action items:

- Limit use of tickler chains to one chain with a maximum ¼ inch link diameter
- Limit total trawl headrope length to 180 feet or less
- Limit trawl vessels to 85 feet or less LOA, and grandfather existing vessels
- Prohibit trotlines when using traps/pots

In addition to the possible benefits to habitat described in 4.3.2.3, and managed species described in 4.3.3.2, this Alternative should provide some incrementally more benefit to managed species. In this case, the yield of shrimp per tow, using a smaller tickler chain will likely be less than when more or heavier chain is used. If fishermen fish at the same level of effort, one might expect this to provide some benefits to populations of shrimp. Most shrimp trawling occurs over soft bottom (mud and silt), in low-energy environments susceptible to disruption. However, trawling has occurred on these habitats for many years with no apparent change in productivity of shrimp. If there was a noticeable reduction in harvest in Federal waters, effort may shift to state waters causing the overall population to not significantly change.

Other species, like some of the snappers (particularly juveniles) that associate with the same habitats might also receive some incremental benefit from these actions.

Prohibition of trotlines might affect fishing effort for stone crab and lobster, thus likely reducing their harvest and increasing their abundance. This action will also have the same potential benefits as described in Alternative 2, for those species for which hard bottom habitat is ecologically important (Tables 3.2.2, 3.2.6, 3.2.21, 3.2.25).

With respect to practicability factor 'population effects on FMU species from changes to EFH,' there should be incrementally more benefits to fish abundance if habitats that have been degraded are allowed to recover and subsequently provide improved carrying capacity for managed species. This Alternative would provide the same benefits as Alternative 2, and would expand to include those species for which sand and soft bottom is ecologically important (Tables 3.2.2, 3.2.6, 3.2.17, 3.2.21, 3.2.25).

4.3.3.4 Alternative 4

Alternative 4: Establish major modifications to fishing gears and gear closures on sensitive habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 3, apply the following action items:

- Limit total trawl headrope length to 120 feet or less
- Limit trawl vessels to 81 feet or less LOA on hard bottom or SAV
- Prohibit use of tickler chains on hard bottom
- Prohibit use of all traps/pots and bottom longlines and buoy gear on coral reefs
- Prohibit all use of anchors on coral reefs, and require use of mooring buoys if vessels need to "anchor" or maintain a stationary position

In addition to the possible benefits to habitat described in 4.3.2.3, and managed species described in 4.3.3.2, this Alternative should provide some incrementally more benefit to managed species than Alternative 3. Prohibiting use of all traps, pots, bottom longlines, and anchors on coral reefs should provide limited benefits to those species that associate with hard bottom and coral reef (snappers, groupers, lobsters, crabs, corals), and some to species that associate with SAV (Tables 3.2.2, 3.2.6, 3.2.17, 3.2.21, 3.2.25). It is not possible to quantify the potential benefits. Most coral reef habitat in the EEZ occurs in areas already closed to pots, traps, and longline-buoy gear. However, some coral areas occur outside the closed areas in the vicinity of the Tortugas (which represent about 1,295 ha or approximately 3200 acres) and potentially in areas west of the Tortugas (Pulley Ridge). Prohibition of traps/pots and longline/buoy gear on coral reef habitat will not likely lead to changes in commercial harvests for fishermen using these gears, however it may lead to some reduction in recreational harvests. Prohibiting the use of anchors while fishing would affect mostly recreational vertical gear fishers; since most coral reef habitat in the EEZ is in areas closed to commercial fishing.

Since most shrimp trawling occurs over soft bottom (mud and silt), prohibiting the use of tickler chains on hard bottom, which might effectively eliminate shrimp fishing on this bottom type, should have a neutral impact on populations of shrimp.

Further Restricting vessel size on hard bottom and SAV and headrope in all habitats will reduce the amount of these habitats that are swept by trawl nets, than proposed in Alternative 3, which will reduce the adverse impacts of the chain and net directly on the bottom to a larger area. It is not exactly known how many shrimp vessels fish in the Gulf or what their gear specifications are, thus the total benefit this action may have is unknown, as discussed in Section 4.3.2.1. However, trawling has occurred on sand and soft sediments for many years with no apparent change in productivity of shrimp. If there was a noticeable reduction in harvest in Federal waters due to these actions, effort may shift to state waters causing the overall population to not significantly change.

With respect to practicability factor 'population effects on FMU species from changes to EFH,' there should be incrementally more benefits to fish abundance if habitats that have been degraded are allowed to recover and subsequently provide improved carrying capacity for managed species. This Alternative would provide the same benefits as Alternative 3, and would expand to include those species for which sand and soft bottom is ecologically important (Tables 3.2.2, 3.2.6, 3.2.17, 3.2.21, 3.2.25).

4.3.3.5 Alternative 5

Alternative 5: Prohibit gears and fishing activities that have adverse impacts on EFH from the EEZ. Apply the following action items:

- Prohibit use of all bottom trawling gear
- Prohibit use of all traps and pots
- Prohibit use of all bottom longline & buoy gear
- Prohibit use of all spears and powerheads
- Prohibit use of all vertical gear
- Prohibit use of all anchors

In addition to the possible benefits to habitat described in 4.3.2.3, and managed species described in 4.3.3.2, this Alternative should provide incrementally more benefit to all managed species than Alternative 4. Prohibition of these gears will eliminate most harvests from the EEZ, and will eliminate any adverse impacts to habitat that may occur from these gears. The abundance of species currently caught during fishing will increase toward an unfished equilibrium, depending on the actual amount of fishing that may occur after the prohibition of these gears.

Indirectly, fishing pressure can be expected to increase significantly in state waters if all fishing in the EEZ were prohibited, and impacts to EFH habitat in these areas would be expected to increase, unless fishing is also restricted in state waters.

With respect to practicability factor 'population effects on FMU species from changes to EFH,' there should be substantially more benefits to fish abundance if habitats that have been degraded are allowed to recover and if fishing mortality approaches zero. This Alternative provides the same benefits as Alternative 4, expanded to include all species (Tables 3.2.2, 3.2.6, 3.2.17, 3.2.21, 3.2.25).

4.3.3.6 Alternative 6 (Preferred alternative)

Alternative 6 (Preferred alternative): Establish minor modifications to fishing gears and a gear closures on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- Regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs
- Prohibit bottom anchoring over coral reefs in HAPCs
- Prohibit use of bottom longlines, buoy gear, and all traps/pots on coral reefs
- Prohibit the use of trawling gear on coral reefs
- Require a weak link in the tickler chain of bottom trawls on all habitats

Alternative 6 (Preferred Alternative) will provide some of the same benefits described in Alternative 2 (Section 4.3.3.2; no trawling on coral; regulation of fishing weights over coral) and some of the same benefits described in Alternative 4 (Section 4.3.3.4; prohibition of bottom longlines, buoy gear and all traps/pots on coral). These measures will directly benefit managed fish and may result in higher productivity if the measures prevent habitat limitation from occurring, or lead to improved habitat. These measures may result in population expansion of some fish species harvested from the Gulf of Mexico.

As Alternative 2, the amount of trawling on coral should be negligible, since most coral are in areas closed to trawling. Prohibition of bottom trawling over all coral reefs should have significant positive impacts on the small coral areas that are not currently protected through other fishery management protections, but overall improvement for coral habitat in the Gulf of Mexico would be minimal. Some deepwater areas of coral that are just being identified, such as Pulley Ridge on the southern edge of the West Florida Shelf (Section 3.2.2.2.1) could benefit from such prohibition in the future. This action should potentially improve the carrying capacity of those species that use coral habitat, particularly those in the Coral FM and Reef Fish FMU. This management measure will likely not affect the catch of any managed species.

As Alternative 4, this Alternative should provide some incrementally more benefit to managed species than Alternative 3. Prohibiting use of all traps, pots, bottom longlines, and anchors on coral reefs should provide limited benefits to those species that associate with hard bottom and coral reef (snappers, groupers, lobsters, crabs, corals), even though most coral reef habitat occurs in areas already closed to these commercial gears (except anchoring). The anchor restrictions would only be for corals in HAPCs; if the Preferred HAPC Alternative is Alternative 9, this would include the Flower Gardens, Florida Middle Grounds, Tortugas Ecological Reserves (North and South), and portions of Pulley Ridge (to be determined through future mapping and research). This Alternative will also provide limited benefits to species that associate with SAV (Tables 3.2.2, 3.2.3, 3.2.6, 3.2.7, 3.2.13, 3.2.14, 3.2.16, 3.2.18, 3.2.21, 3.2.22, 3.2.25, and 3.2.26). It is not possible to quantify the potential benefits. These gear prohibitions will not likely lead to changes in commercial harvests for fishermen using these gears, however it may lead to some reduction in recreational harvests. Prohibiting the use of anchors while fishing on these habitats would affect mostly recreational vertical gear fishers.

Requiring the use of a weak link on tickler chains used with bottom trawls and the regulations of the amount of weights and sinkers used with vertical gear should primarily have positive environmental benefits to those organisms with vertical relief found on hard bottoms (Section 4.3.3.2 and 4.3.2.6), the benefits will be mostly to those species for which hard bottoms are ecologically important (Tables 3.2.2, 3.2.6, 3.2.21, 3.2.25). As described earlier, this alternative identifies that regulation of weights and sinkers needs to be addressed through future action of the Council. Fishing effort data, such as collected by log book for commercial fishermen or through the MRFSS does not request information on the amount of weight used, nor how many times the fishing line is dropped to the bottom, which would be a measure of how often weights from vertical gear come into contact with the bottom. Due to the nature of this type of fishing, this would be a very onerous and costly data collection task, and would require an observer on the vessel to record (for commercial or recreational). Addition methods to gather such information need investigation.

With respect to practicability factor 'population effects on FMU species from changes to EFH,' there should be minor changes in fish abundance if habitats that have been degraded are allowed to recover and subsequently provide improved carrying capacity for managed species. This would most likely affect those species for which coral and hard bottom is ecologically important (Tables 3.2.2, 3.2.6, 3.2.21, 3.2.25).

4.3.3.7 Alternative 7

Alternative 7: Establish some minor modifications to fishing gears and one major gear closure on sensitive live hard bottom habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. The actions include:

- Limit bottom longline sets to 5 miles in length, and to three sets/day
- Prohibit trotlines when using traps/pots
- Prohibit all anchoring
- Enact a seasonal closure for shrimp trawl fishing

Available information does not provide conclusive evidence that any managed species are currently habitat limited. However, habitat limitation could occur, but go undetected. These measures will directly benefit fish and may result in higher productivity if the measures individually or combined prevent habitat limitation from occurring, or lead to improved habitat. The potential benefits to habitats are described in section 4.3.2.7. These measures may result in population expansion of some fish species harvested from the Gulf of Mexico.

Limiting longline sets to 5-miles and three sets per day could benefit the targeted species, if days at sea remain relatively stable. However, there is also the chance that there will not be a decline in catch rates for fishermen. Each fisherman uses different spacings between hooks on the line and might find that a different number of hooks per line may result in similar catch rates to what he/she was achieving before. Additionally, less fishing pressure (amount of line in the water) can increase the yield per catch. More study will be needed to identify if there are any positive or negative benefits to federally managed species.

Prohibition of trotlines might affect fishing effort for stone crab and lobster, thus likely reducing their harvest and increasing their abundance. This action will also have the same potential benefits as described in Alternative 2, for those species for which hard bottom habitat is ecologically important (Tables 3.2.2, 3.2.6, 3.2.21, 3.2.25).

Prohibition of anchoring on live hard bottom environments would be expected to provide the maximum protection from those fisheries that require anchoring (commercial or recreational). If habitats that have been degraded by anchoring are allowed to recover they will provide improved carrying capacity for managed species. This would most likely affect those species for which coral and hard bottom is ecologically important, particularly reef fish, certain coastal migratory pelagics, and lobster (Tables 3.2.2, 3.2.6, 3.2.21, 3.2.25).

The seasonal shrimp trawl closure will benefit managed species to the degree that it reduces or prevents habitat damage, and should benefit shrimp and some finfish species. It may be expected that the harvest of shrimp from these areas would likely be reduced, however, this depends on the timing of the closed season, and whether the same overall shrimp fishing effort can be achieved during the open season (the estimated 0-81 days per year per area). At this time, it is not possible to directly identify or quantify what the benefits to shrimp and other managed species would be.

With respect to practicability factor 'population effects on FMU species from changes to EFH,' there should be minor changes in fish abundance if habitats that have been degraded are allowed to recover and subsequently provide improved carrying capacity for managed species. This would most likely affect those species for which coral and hard bottom is ecologically important (Tables 3.2.2, 3.2.6, 3.2.21, 3.2.25).

4.3.4 Consequences for non-Federally managed fish

4.3.4.1 Alternative 1 (No Action/Status Quo)

Alternative 1. (No Action/Status Quo): Use existing regulations to prevent, mitigate, or minimize adverse fishing impacts in State and Federal waters of the Gulf of Mexico.

Alternative 1 is the status quo alternative. The impacts of this Alternative are the same as those described in Section 4.3.3.1 Any trends in ongoing habitat damage from fishing gears would continue, barring other external factors.

With respect to practicability factor "ecosystem changes from changes in EFH," if the habitat damage leads to reductions in abundance for any non-Federally managed species, that decline would continue. These affected fishes might be prey of managed species. Available information does not provide conclusive evidence that any non-managed species are currently habitat limited.

However, habitat limitation could occur, but go undetected. It is also not clear how much habitat damage has occurred from adverse impacts of fishing.

4.3.4.2 Alternative 2

Alternative 2: Establish minor modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- No bottom trawling over coral
- Require aluminum doors on trawls
- Limit bottom longline sets to 6 miles in length, limited to three sets/day on hard bottom
- Require circle hooks on all vertical lines and allow maximum sinker weights of 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs, and handlines
- Require use of buoys on all anchors

Consequences of Alternative 2 for non-Federally managed species would be the similar to those discussed for Federally managed species (Section 4.3.3.2). Potential benefits to habitats and fishes would include elimination of trawl damage to corals, reduced trawl door damage to habitats, reduced bottom longline damage to habitats (especially hard bottoms), increased survival of catch and release fishes, and less anchor damage to habitats. If some of the species benefiting from these actions were prey of managed species, then managed species would benefit indirectly as well.

With respect to practicability factor "ecosystem changes from changes in EFH," although available information does not provide conclusive evidence that any non-managed species are currently habitat limited nor how much habitat damage has occurred from adverse fishing impacts, there should be minor changes in fish abundance if habitats that have been degraded are allowed to recover and subsequently provide improved carrying capacity for non-managed species. This would most likely affect those species for which corals and hard bottom are ecologically important (Section 3.2.5). The affected fishes might be prey of managed species.

4.3.4.3 Alternative 3

Alternative 3: Establish moderate modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 2, apply the following action items:

- Limit use of tickler chains to one chain with a maximum ¼ inch link diameter
- Limit total trawl headrope length to 180 feet or less
- Limit trawl vessels to 85 feet or less LOA, and grandfather existing vessels
- Prohibit trotlines when using traps/pots

Consequences of Alternative 3 for non-Federally managed species would be similar to those discussed for Federally managed species (Section 4.3.3.3). Potential benefits to habitats and non-Federally managed species would include reduced damage to habitats from trawling activities (especially from tickler chains), and less damage to habitats (primarily corals and hard bottoms) from traps/pots on trotlines. If some of the species benefiting from these actions were prey of managed species, then managed species would benefit indirectly as well.

With respect to practicability factor "ecosystem changes from changes in EFH," there should be incrementally more benefits to fish abundance if habitats that have been degraded are allowed to recover and subsequently provide improved carrying capacity for non-managed species. This Alternative would provide the same benefits as Alternative 2, and would expand to include those species for which sand and soft bottom is ecologically important (Section 3.2.5).

4.3.4.4 Alternative 4

Alternative 4: Establish major modifications to fishing gears and gear closures on sensitive habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 3, apply the following action items:

- Limit total trawl headrope length to 120 feet or less
- Limit trawl vessels to 81 feet or less LOA on hard bottom or SAV
- Prohibit use of tickler chains on hard bottom
- Prohibit use of all traps/pots and bottom longlines and buoy gear on coral
- Prohibit all use of anchors on coral, and require use of mooring buoys if vessels need to "anchor" or maintain a stationary position

Alternative 4 consequences for non-Federally managed species would be the same as those for Federally managed species. Potential benefits to non-Federally managed species would include even less damage to habitats (especially hard bottoms) from trawling activities than Alternative 3, and an elimination of damage to coral from bottom longlines, traps/pots, and anchors. However, as discussed above these measures may cause a shift to greater fishing effort in state waters.

With respect to practicability factor "ecosystem changes from changes in EFH," there should be incrementally more benefits to non-managed fish abundance if habitats that have been degraded are allowed to recover and subsequently provide improved carrying capacity for non-managed species. This Alternative would provide the same benefits as Alternative 3, and would expand to include those species for which sand and soft bottom is ecologically important (Section 3.2.5).

4.3.4.5 Alternative 5

Alternative 5: Prohibit gears and fishing activities that have adverse impacts on EFH from the EEZ. Apply the following action items:

- Prohibit use of all bottom trawling gear
- Prohibit use of all traps and pots
- Prohibit use of all bottom longline & buoy gear
- Prohibit use of all spears and powerheads
- Prohibit use of all vertical gear

- Prohibit use of all anchors

Consequences of Alternative 5 for non-Federally managed species would be similar to those discussed for Federally managed species. This alternative would eliminate most harvest of non-Federally managed species from the EEZ, and would eliminate most habitat damage currently occurring due to these fishing gears. However, it would almost certainly shift a large amount of fishing effort to state waters.

With respect to practicability factor "ecosystem changes from changes in EFH," there should be substantially more benefits to non-managed fish abundance if habitats that have been degraded are allowed to recover and if fishing mortality approaches zero. This Alternative provides the positive benefits beyond those of all the other alternatives.

4.3.4.6 Alternative 6 (Preferred alternative)

Alternative 6 (Preferred Alternative): Establish minor modifications to fishing gears and a gear closures on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- Regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs
- Prohibit bottom anchoring over coral reefs in HAPCs
- Prohibit use of bottom longlines, buoy gear, and all traps/pots on coral reefs
- Prohibit the use of trawling gear on coral reefs
- Require a weak link in the tickler chain of bottom trawls on all habitats

Consequences of Alternative 6 for non-Federally managed species would be similar to those discussed for Federally managed species (Section 4.3.3.6). Available information does not provide conclusive evidence that any managed species are currently habitat limited. However, if it was occurring undetected, these measures could directly benefit non-managed fish resulting in higher productivity if habitats improve.

Potential benefits would be to those non-Federally managed species dependent primarily on coral habitat. If individual species are dependent on a variety of habitats, then only that lifestage dependent on coral would be expected to potentially benefit from these measures. There is strong likelihood that certain fishing activities would shift to other habitats or regions, if possible, thus potentially causing increased pressure on non-Federally managed species and life stages in these habitats.

With respect to practicability factor "ecosystem changes from changes in EFH," although available information does not provide conclusive evidence that any non-managed species are currently habitat limited nor how much habitat damage has occurred from adverse fishing impacts, there should be minor changes in fish abundance if habitats that have been degraded are allowed to recover and subsequently provide improved carrying capacity for non-managed species. This would most likely affect those species for which corals and hard bottom are ecologically important (Section 3.2.5). The affected fishes might be prey of managed species.

4.3.4.7 Alternative 7

Alternative 7: Establish some minor modifications to fishing gears and one major gear closure on sensitive live hard bottom habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. The actions include:

- Limit bottom longline sets to 5 miles in length, and to 3 sets/day
- Prohibit trotlines when using traps/pots
- Prohibit all anchoring
- Enact a seasonal closure for shrimp trawl fishing

Alternative 7 consequences for non-Federally managed species would be the same as those for Federally managed species. Potential benefits to non-Federally managed species would include less damage to live hard bottom habitats from longlining and trawling activities, and an elimination of habitat damage from trotlines and anchors. However, as discussed in Section 4.3.4.6 and in other sections, these measures may cause a shift to greater fishing effort on other bottom types, predominantly sand/shell, silt and clay, or to all habitats in state waters.

With respect to practicability factor "ecosystem changes from changes in EFH," there should be incrementally more benefits than Alternatives 1, 2, or 3, but less benefit than Alternative 4 for non-managed fish species dependent on live hard bottom habitats. Those habitats and ecosystems that have been degraded and allowed to recover should subsequently provide improved carrying capacity for non-managed species.

4.3.5 Consequences for marine mammals and protected species

4.3.5.1 Alternative 1 (No Action/Status Quo)

Alternative 1. (No Action/Status Quo): Use existing regulations to prevent, mitigate, or minimize adverse fishing impacts in State and Federal waters of the Gulf of Mexico.

Alternative 1 is the status quo alternative. There would be no direct benefits to protected species through this Alternative. Any potential impacts to marine mammals and protected species that currently exist due to fishing activities would continue, unless addressed through other fishery plan amendments. Several types of interactions, such as between sea turtles and shrimp trawls, have been addressed through other management efforts (i.e. the requirement that shrimp fishermen use sea turtle exclusion devices (TEDs)), but these have not been implemented to protect habitat.

With respect to practicability factor "ecosystem changes from changes in EFH," if ongoing habitat damage leads to reductions in abundance for any marine mammals and other protected species, that decline would continue. However, marine mammals and other protected species in the Gulf of Mexico are not limited by available habitat in marine offshore waters, where Federal fishing activities occur. Gulf sturgeon and smalltooth sawfish are impacted due to alterations of their habitats (Sections 3.2.6.3.1 and 3.2.6.3.2), however these habitats occur within state boundaries (shallow coastal waters, estuaries, rivers) and the primary habitat impacts come from non-fishing activities (dredge and fill, channalization, dams). Smalltooth sawfish became vulnerable to extinction due to entanglement in nets, however net fishing has been banned in state waters in south Florida.

Four species in the Reef Fish FMU, the speckled hind, Goliath grouper, Warsaw grouper and Nassau grouper, are on the NOAA Fisheries candidate list of ESA species. The potential impacts to these species is the same as that described in Section 4.3.3.1. Habitat damage is expected to lead to reductions in abundance for species over time, and that decline would continue.

4.3.5.2 Alternative 2

Alternative 2: Establish minor modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- No bottom trawling over coral
- Require aluminum doors on trawls
- Limit bottom longline sets to 6 miles in length, limited to three sets/day on hard bottom
- Require circle hooks on all vertical lines and allow maximum sinker weights of 2 pounds for bandit rigs and 0.5 pounds for rod and reel, electric rigs, and handlines
- Require use of buoys on all anchors

Potential consequences of Alternative 2 for protected species would be the same as for those discussed for all other species, as discussed in Sections 4.3.3.2 and 4.3.4.2. Habitat benefits to coral and hard bottom should provide positive benefits to sea turtles that use these habitats for feeding and growing to maturity. The amount of trawling on coral should be negligible, as most coral are in areas closed to trawling and shrimp do not occur in high abundance over coral. Thus, the potential reduction of the direct interaction between sea turtles and shrimp trawl gear should be negligible.

Reduction of longline gear usage, through shorter longline sets, with limits of three per day on hard bottom, may provide positive benefits to sea turtles. Based on very limited observer data in the bottom longline shark fishery, and recent data collected via the Southeast Fishery Science Center's supplementary discard data form, sea turtles can be taken on this gear (J. Lee, Office of Protected Species, pers. comm.), therefore any overall effort reduction would potentially decrease such interactions. There are no reported marine mammal interactions with bottom longlines in the Gulf.

In some fisheries, such as highly migratory recreational fisheries, use of circle hooks promotes conservation by reducing bycatch and lowering post-release mortality (NOAA 2003b). The same would be true for those fisheries that use vertical gears, if there were a history of interaction with protected species. There is no information that this is a problem, thus the potential consequences of this action would be neutral. The same is true for use of buoys on anchors. For example, in offshore Federal waters, there are no Gulf of Mexico Bottlenose Dolphin stocks which have Federal commercial fishery interactions above sustainable levels.

The majority of the fishery interactions, in particular for the Gulf of Mexico Bottlenose Dolphin Stocks, occur in coastal waters, out of the jurisdiction of this proposed document.

With respect to practicability factor "ecosystem changes from changes in EFH," there should be some, minimal improvement to the ecosystem from this alternative, compared with the status quo (Alternative 1).

4.3.5.3 Alternative 3

Alternative 3: Establish moderate modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 2, apply the following action items:

- Limit use of tickler chains to one chain with a maximum ¼ inch link diameter
- Limit total trawl headrope length to 180 feet or less
- Limit trawl vessels to 85 feet or less LOA, and grandfather existing vessels
- Prohibit trotlines when using traps/pots

Potential consequences of Alternative 3 for protected species would be incrementally better than that described for Alternative 2 for some species, but potentially negative for other species. Habitat benefits to coral and hard bottom should provide positive benefits to sea turtles in particular, as they use these habitats for feeding and growing to maturity. Maintaining total trawl headrope length to 180 feet or less, will not only reduce the amount of overall trawl impact on habitat, but will also reduce total trawl opening or spread through the water, which may have some, limited impact on the interaction with sea turtles.

The action item to prohibit trotlines when using traps/pots would likely increase the number of vertical lines in the water column, since each individual trap would require its own buoy line. These actions may increase the potential risk of entanglement of marine mammals. The sperm whale, which is listed as endangered under the ESA, is known to use the Gulf of Mexico for breeding and calving; hence, this proposed action may adversely impact the species should the gear and animals overlap. There is also evidence that both the humpback whale and the fin whale occur and use the Gulf of Mexico as a possible winter grounds. Additionally, there is evidence of the Atlantic right whale in the Gulf of Mexico; even though it may have represented strays from the winter grounds, this proposed action may not likely be beneficial to the species. All of these species are covered under the Atlantic Large Whale Take Reduction Plan (ALWTRP). The actions contradict the overriding principles of the ALWTRP. At an April 2003 meeting, the team recommended that the risk associated with vertical lines and the profile of all ground lines needed to be reduced. Consideration of the final ALWTRP's policy is needed.

Since there are no Gulf of Mexico Bottlenose Dolphin stocks which have Federal commercial fishery interactions above sustainable levels, the actions in the Alternative are considered neutral with respect to all dolphins.

Thus, with respect to practicability factor "ecosystem changes from changes in EFH," although there may be some, minimal benefit to sea turtles from several individual actions, this alternative has the potential to introduce a greater threat to large whales compared with the status quo (Alternative 1). Overall, the impact to marine mammals and other protected species would be neutral to moderately negative.

4.3.5.4 Alternative 4

Alternative 4: Establish major modifications to fishing gears and gear closures on sensitive habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 3, apply the following action items:

- Limit total trawl headrope length to 120 feet or less
- Limit trawl vessels to 81 feet or less LOA on hard bottom or SAV
- Prohibit use of tickler chains on hard bottom
- Prohibit use of all traps/pots and bottom longlines and buoy gear on coral
- Prohibit all use of anchors on coral, and require use of mooring buoys if vessels need to "anchor" or maintain a stationary position

Potential consequences of Alternative 3 for protected species would be incrementally better than that described for Alternative 2 for some species, but potentially negative for other species. As discussed in Section 4.3.5.2, habitat benefits to coral and hard bottom should provide positive benefits to sea turtles in particular, as they use these habitats for feeding and growing to maturity. Maintaining total trawl headrope length to 120 feet or less, will reduce total trawl opening or spread through the water, which may have some, limited impact on the interaction with sea turtles.

Prohibiting all traps, pots, bottom longline and buoy gear on coral might have some, limited benefit for protected species that could potentially become entangled with these gear. However, potential interactions are predominantly with large whales which do not necessarily associate with coral reef habitat in particular, which are usually in relatively shallow water. Thus, the consequences to this action would be considered neutral to slightly beneficial.

The action item to require the use of mooring buoys would likely increase the number of permanent vertical lines in the water column, although the use of temporary vertical anchor lines should be reduced (a single mooring buoy usually can handle more than one vessel, sometimes three or four vessels). Thus this action may have some, limited negative impact on marine mammals. However, in addition to the actions listed under Alternative 3 apply which equally apply for Alternative 4, there is an increase in the risk of entanglement of marine mammals with the increased number of vertical lines in the water column, as discussed under Alternative 3 (Section 4.3.5.3). These threats apply to the sperm and Atlantic right whales, which are listed as endangered under the ESA, and the humpback and fin whales. These actions also do not take ALWTRP policy into consideration.

Since there are no Gulf of Mexico Bottlenose Dolphin stocks which have Federal commercial fishery interactions above sustainable levels, the actions in the Alternative are considered neutral with respect to all dolphins.

With respect to practicability factor "ecosystem changes from changes in EFH," although there may be some, minimal benefit to sea turtles from several individual actions, this alternative has the potential to introduce a greater threat to large whales compared with the status quo (Alternative 1). Overall, the impact to marine mammals and other protected species would be neutral to moderately negative.

4.3.5.5 Alternative 5

Alternative 5: Prohibit gears and fishing activities that have adverse impacts on EFH from the EEZ. Apply the following action items:

- Prohibit use of all bottom trawling gear
- Prohibit use of all traps and pots
- Prohibit use of all bottom longline & buoy gear
- Prohibit use of all spears and powerheads
- Prohibit use of all vertical gear
- Prohibit use of all anchors

Consequences of Alternative 5 for marine mammals and protected species would be the same as those discussed for all other species in Sections 4.3.3.5 and 4.3.4.5. Prohibition of these gears will eliminate most harvests from the EEZ, and should eliminate any adverse impacts to protected species from these gears.

However, as discussed above, these measures may cause a shift to greater fishing effort in state waters. Although there are no Gulf of Mexico bottlenose dolphin stocks which have Federal commercial fishing interactions above sustainable levels, the majority of fishery interactions for these stocks occur in coastal waters (out of the regulatory jurisdiction of this particular document). If fishing effort is increased in state waters, it may pose a higher level of threat to these stocks.

Conversely, removal of all fishing gear that can interact with protected species offshore (longline and buoy gear, traps and pots and their buoy lines, trawl gear, all anchors) would eliminate the potential negative interactions of gear with large whales, other marine mammals, sea turtles, and sea birds.

With respect to practicability factor "ecosystem changes from changes in EFH," there will be positive benefits to all marine mammals and protected species in the offshore environment, with some potential negative impacts to dolphins and sea turtles in estuarine, nearshore (coastal environments). Overall, it is anticipated that the positive impacts will outweigh the negative impacts.

4.3.5.6 Alternative 6 (Preferred alternative)

Alternative 6 (Preferred Alternative): Establish minor modifications to fishing gears and a gear closures on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- Regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs
- Prohibit bottom anchoring over coral reefs in HAPCs
- Prohibit use of bottom longlines, buoy gear, and all traps/pots on coral reefs
- Prohibit the use of trawling gear on coral reefs
- Require a weak link in the tickler chain of bottom trawls on all habitats

Consequences of Alternative 6 for marine mammals and protected species would be the same for some actions as Alternative 2, and for other actions as Alternative 4.

The amount of trawling on coral should be negligible, as most coral are in areas closed to trawling and shrimp do not occur in high abundance over coral. Thus, the potential reduction of the direct interaction between sea turtles and shrimp trawl gear should be negligible.

Prohibiting all traps, pots, bottom longline and buoy gear on coral might have some, very limited benefit for protected species that could potentially become entangled with these gear. In particular, there may be some limited benefit to sea turtles which associate with coral habitat more than other protected species. Interactions with marine mammals (i.e., large whales) is very remote, particularly on the limited amount of coral habitat in the Gulf. Finally, regulating fishing weights or requiring a weak link on tickler chain on bottom trawls should have no impact on protected species.

Therefore, with respect to practicability factor "ecosystem changes from changes in EFH," there should be some limited positive benefits to sea turtles, in the offshore environment, and no impact, positive or negative, on other protected species, as a result of the actions in Alternative 6. In comparison, the protections provided to marine mammals, sea turtles, sea birds and other protected species under the Marine Mammal Protection Act and Endangered Species Act are much more stringent and enforceable, prohibit most 'take,' and include protections for habitat used by these species that are more protective than those allowed under EFH regulations.

4.3.5.7 Alternative 7

Alternative 7: Establish some minor modifications to fishing gears and one major gear closure on sensitive live hard bottom habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. The actions include:

- Limit bottom longline sets to 5 miles in length, and to three sets/day
- Prohibit trotlines when using traps/pots
- Prohibit all anchoring
- Enact a seasonal closure for shrimp trawl fishing

Reduction of longline gear usage, through shorter longline sets, with limits of three per day on hard bottom, may provide positive benefits to sea turtles. Based on very limited observer data in the bottom longline shark fishery, and recent data collected via the Southeast Fishery Science Center's supplementary discard data form, sea turtles can be taken on this gear (J. Lee, Office of Protected Species, pers. comm.), therefore any overall effort reduction would potentially decrease such interactions. There are no reported marine mammal interactions with bottom longlines in the Gulf.

Prohibiting trotlines when using traps/pots would likely increase the number of vertical lines in the water column, since each individual trap would require its own buoy line. These actions may increase the potential risk of entanglement of marine mammals. The sperm whale, which is listed as endangered under the ESA, is known to use the Gulf of Mexico for breeding and calving; hence, this proposed action may adversely impact the species should the gear and animals overlap. There is also evidence that both the humpback whale and the fin whale occur and use the Gulf of Mexico as a possible winter grounds. Additionally, there is evidence of the Atlantic right whale in the Gulf of Mexico; even though it may have represented strays from the winter grounds, this proposed action may not likely be beneficial to the species. All of these species are covered under the Atlantic Large Whale Take Reduction Plan (ALWTRP). The actions contradict the overriding principles of the ALWTRP. At an April 2003 meeting, the team recommended that the risk associated with vertical lines and the profile of all ground lines needed to be reduced. Consideration of the ALWTRP's policy is needed.

The removal of all interactions between anchor lines and protected species offshore on live hard bottom areas would eliminate the potential negative interactions of gear with large whales, other marine mammals, sea turtles, and sea birds.

The seasonal closure of the large, mixed hard bottom-sand areas off the west coast of Florida to shrimp trawling should provide positive benefits to sea turtles that use these habitats for feeding and growing to maturity. Although shrimp fishermen target the sandy or silty patches between the hard bottom areas and do not generally try to fish on the hard bottom, turtles cover the entire area, and also move between the patches of hard bottom. However, the total level of benefit would be dependent upon the season of closure. Sea turtles are generally in higher concentrations in those areas closest to shore during nesting season, from May – October.

4.3.6 Consequences for the Human Environment

4.3.6.1 Alternative 1 (No Action/Status Quo)

Alternative 1 (No Action/Status Quo): Use existing regulations to prevent, mitigate, or minimize adverse fishing impacts in State and Federal waters of the Gulf of Mexico.

4.3.6.1.1 Economic impacts

From an economic perspective, an analysis of Alternative 1 (No Action) requires a comparison of the costs associated with taking no action with the benefits of taking no action. Certainly, if the different gears are not causing habitat deterioration, there would be no benefits (increases in producer and/or consumer surplus) to restricting fishing practices (types of gears to be used on different types of habitats) since the different gears are causing no externalities (i.e., the marginal private cost curve, as illustrated in Figure 4.3.1, is equivalent to the marginal social cost curve).

Just as there would be no benefits associated with taking no action, however, costs (i.e., reduction in consumer or producer surplus) would also be zero.

Information contained in this document suggests, however, that there is at least the probability that certain gears can cause habitat degradation, with the probability and severity depending upon the type of gear and the type of habitat. This would, in theory, suggest that certain fishing restrictions (certain gears on certain habitats) may be warranted. Whether the restrictions provide a movement towards an economically efficient outcome depends, of course, on benefits relative to costs associated with the specific restrictions (management measures). Any individual fishermen driven out of business by restrictions will not reap the long-term benefits of increased fish abundances due to these habitat protection measures. However, there should still be net gains to the fishery as a whole over the long term if the habitat protections help improve environmental conditions to the stock.

As previously noted, primary benefits are likely to be of four primary types. The first is increased consumer and/or producer surplus derived from commercial harvesting activities. The second is consumer surplus derived from recreational fishing activities. The third reflects increased benefits from non-consumptive activities, such as diving (assuming the taking of fish is not a purpose of the trip). Finally, benefits, associated with existence value, may be enhanced from fishing restrictions. Each of these is discussed separately in the following sections.

With respect to the practicability factor "net economic change to fishers," it is expected that the short term economic cost of no-action will be zero. Alternative 1 is therefore practicable from the perspective of this evaluation factor. In the longer term, however, continued habitat degradation, to the extent that this is occurring, will add to the factors currently threatening fisheries productivity, including overfishing and impacts from non-fishing activities, potentially reducing further the productivity of the fisheries under FMPs.

4.3.6.1.1.1 Producer and consumer surplus in the commercial harvesting sector

Enhancement (or a decline in reduction) in consumer surplus resulting from certain gear restrictions on certain habitats is premised on the concept that taking such action will enhance (or at a minimum retard the rate of decay) stocks which, in turn, increases long-term harvest. The increase in long-term harvest will translate into increased consumer surplus if, and only if, the increased harvest translates into a reduction in price for the harvested product. To a large extent, many of the species commercially harvested in the Gulf of Mexico compete directly with a large and growing import market. Gulf of Mexico landings of shrimp, for example, pale in comparison to imports and it is unlikely that marginal (or even relatively large) increases in long-run harvests of shrimp will result in any significant decline in price. This generalization likely holds for many other species, such as spiny lobster and certain types of snapper. Hence, it appears unlikely that habitat enhancement will result in any substantial increase in consumer surplus associated with increased commercial harvest.[56]

[56] To some extent, this generalization should be tempered by the fact that consumers may prefer fresh, domestically landed product to that of frozen imports. To the author's knowledge, however, there has

Producer surplus from commercial fishing activities is equal to revenues over and above that amount necessary to attract scarce resources into the production process (see Just et al., 1982 for a detailed discussion of producer surplus). With respect to commercial fishing activities, it is approximated by industry profits. These profits tend to be directly related to the management regime in place. In an open access fishery, for example, profits will, in theory, be equal to zero assuming a homogenous fleet and equilibrium conditions. As one moves to a rights-based management system, profits increase accordingly.

As discussed throughout the text, a large number of management regimes are employed in the Gulf of Mexico, the type of regime dependent upon the species (or group) considered. Of the Federally managed species, the shrimp fishery likely most approximates an open-access system. There are no qualifications for entry into the fishery at the Federal level and, as such, effort can be extremely malleable (including new entrants) with respect to changes in expected profitability. The open-access nature of the fishery does not imply that producer surplus is driven to zero, however. The fishery is extremely heterogeneous (implying the likely existence of inframarginal rents) and, given the annual nature of the stock and fluctuating prices, the fishery is likely to be rarely in an economic equilibrium. Profits, however, are known to be relatively low, particularly at present, and it is unlikely that any "significant" long-term producer surplus will be achieved in the absence of some change in management regime; even with habitat protection or enhancement.

Other fisheries, such as the spiny lobster fishery, may be generating more producer surplus (for a given amount of scarce resources used in the production process) as a result of the management regime. Specifically, the trap certificate program, which increasingly limits the number of traps employed by the industry, could result in increasing producer surplus, depending upon individual fishermen's reactions to fishing fewer traps (the frequency of hauling the traps may increase which would tend to diminish gains in producer surplus).

Finally, consider the reef fish fishery. Recent analysis by Weninger and Waters (2002) suggests that producer surplus from reef fish fishing activities in the northern Gulf of Mexico is considerably less than what would be achieved under a rights-based management system.

In summary, while producer surplus is undoubtedly being generated in the Gulf of Mexico commercial fishing sector under "normal" conditions, it is likely to be significantly less than would be the case under a rights-based management regime.[57] With a total dockside value of all commercial fishing activities in the Gulf of Mexico generally approximating $500 million annually, however, it seems relatively safe to conclude that annual producer surplus does not

been no empirical studies examining this issue and it would only be relevant if there was not a significant price differential (i.e., domestic product being higher than the imported product).

[57] The qualification of "normal" conditions is included in this statement because of the current situation in the shrimp fishery; by far the largest commercial component. Specifically, the rapid decline in dockside price in conjunction with an inability of shrimpers to instantaneously exit the fishery suggests that profits in the industry are likely to be negative at present. Through time, however, one would anticipate additional exit from the fishery (assuming prices do not increase) and a return to 'normal' profitability conditions.

exceed the $100 million mark (this would include both Federally managed and non-managed species).

Furthermore, given the management regimes currently in place, marginal changes in habitat protection and/or enhancement will likely translate into only minor increases in producer surplus in the commercial fishing sector, primarily through increases in inframarginal rents. This statement, in addition, is premised on the hypothesis that further protection/enhancement of essential fish habitat results in an increase in the carrying capacity of commercially relevant fish stocks (either directly or indirectly). There is insufficient information to determine how these fish stocks may be enhanced as a result of additional protection of essential fish habitat.

In general, theory suggests that the size of a given fish stock at any point in time is related to two primary factors: (a) the carrying capacity of the environment upon which the fish stock is dependent and (b) current and past levels of effort [either directed or through bycatch]. Holding other factors constant, an increase in carrying capacity would result in a long-run increase in stock size. Hence, increases (decreases) in essential fish habitat would result in an increase (decrease) in stock size. While known in theory, empirical estimation of this relationship is generally lacking due to (a) the inability of biological models to fully incorporate carrying capacity factors in the empirical analysis and (b) less than complete knowledge and information on the factors [including essential fish habitat] that contribute to changes in carrying capacity. As the biological models become more refined through time, more detailed estimation of the relationship between essential fish habitat and stock size should be forthcoming.

4.3.6.1.1.2 Consumer surplus in the recreational sector

In theory, protection/enhancement of the habitat can translate into increased consumer surplus in the recreational sector if doing so results in an increase in carrying capacity and increased stock size. The increase in the stock size would, one might hypothesize, result in an increase in demand for recreational fishing trips. Assuming the cost of the fishing trip does not vary as a result of increased stock size, consumer surplus would be enhanced.

However, a portion of the increased consumer surplus may be dissipated over time as a result of the open-access nature of all recreational fisheries in the Gulf of Mexico. Specifically, increasing stocks result in an increased demand for recreational trips. This increased demand would translate into an increase in the quantity being taken, at a given cost per trip. As the number of trips increases, catch per trip among all participants is expected to decline. The declining catch per trip, the result of increased participation, would, in theory, suggest declining consumer surplus in the long run (though potentially higher than prior to habitat protection/enhancement).

4.3.6.1.1.3 Consumer surplus from non-consumptive activities

Non-consumptive use activities of the Gulf of Mexico fishery resources would include activities such as diving (where the purpose of the diving trip does not include the take of fish by spearfishing or powerheads). There is no information pertaining to the consumer surplus of such activities but it is certainly positive. Protection or enhancement of essential fish habitat could increase consumer surplus associated with these activities via at least two mechanisms. First, there may be additional benefits (consumer surplus) from diving in a less disturbed (i.e., more pristine) environment. Second, to the extent that protection of alternative habitats (via gear restrictions) results in an enhancement of fish stocks, divers and other passive users may receive additional utility (benefits) associated with increased visual sightings of fish.[58] Hence, while there may be an increase in consumer surplus associated with protection/enhancement of essential fish habitat, quantifying it would be impossible without information on the number of passive users and their collective willingness-to-pay for such protection/enhancement.

4.3.6.1.1.4 Consumer surplus from existence value

Economic theory suggests that society places a value on the knowing that unique sites remain in a relatively undisturbed state and, as such, would be willing to pay for their protection. To the extent that the unique sites have been negatively impacted as a result of anthropogenic activities, theory would furthermore suggest that society would, in many instances, be willing to pay for at least some level of restoration. This willingness to pay represents the demand for habitat protection/enhancement. The amount that society would be willing to pay depends upon a number of factors, including uniqueness and irreplaceability. While there is undoubtedly some existence value associated with some of the unique habitats in the Gulf of Mexico (e.g., coral reefs and hard bottoms), attempting to quantify it would be futile.

In summary, essential fish habitat does provide economic benefits. If fishing gears do result in habitat degradation, the 'No Action' alternative would result in continued deterioration of the habitat. This would be the cost of taking 'No Action'. This cost, however, must be weighed against the costs of taking action. Since the costs associated with taking no action are, for the most part, unknown (i.e., the benefits that would accrue if action were to be taken), it can not be concluded that the 'No Action' alternative leads to an outcome with lower economic net benefits than any of the other alternatives listed below.

4.3.6.1.2 Socio-economic impacts

The social impacts of no action would depend upon the long term effects upon habitat if no efforts are made to prevent, mitigate, or minimize damage from fishing gears. If habitat becomes further degraded, future stocks may be affected and make it difficult to sustain continued participation in some fisheries. Overall, some short term impacts may be avoided by no action, but there may also be long term impacts that occur and negatively affect habitat and fish stock, thereby impacting fishermen and their communities

[58] This statement assumes that fish stocks are not driven back down to pre-protection levels via commercial and/or recreational activities.

The nature of those impacts on communities may depend upon the duration of the anticipated action. If habitat becomes degraded as a result of no action and fish stocks become further depleted over time, both commercial and recreational sectors will be impacted. If the loss of habitat is severe and a decline in both the commercial and recreational fishing sectors results there may be far reaching impacts that will include support industries for both sectors within the community. These impacts may happen slowly over time, in which case it may be difficult to measure as other forms of social impacts may have some bearing on the outcome. On the other hand, the council may be forced to implement a strict regimen of management in the future which would have immediate and severe impacts. Finally, because the council is mandated to take some action, it is unlikely that this alternative will be chosen.

With respect to the practicability factor "equitability of costs among communities," no habitats would be provided any special protection from fishing gear impacts, except for those already provided protection through existing FMP regulation. But because the potential net negative impacts to habitats and the fisheries they support are for the most part unknown or extremely difficult to predict, it is not possible to predict if one community would be impacted more than another.

4.3.6.2 Alternative 2

Alternative 2: Establish minor modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- No bottom trawling over coral
- Require aluminum doors on trawls
- Limit bottom longline sets to 6 miles in length, limited to three sets/day on hard bottom
- Require circle hooks on all vertical lines and allow maximum sinker weights of 2 pounds on bandit rigs and 0.5 pounds on rod and reel, electric rigs, and handlines
- Require use of buoys on all anchors

4.3.6.2.1 Economic impacts

To examine this alternative, each of the five actions will initially be analyzed separately. Based on this analysis, some generalizations will then be presented regarding the combination of actions.

The intent of no bottom trawling over coral is to protect the coral resources from damage associated with trawling activities. The premise that benefits would accrue from such action is, of course, conditioned on three overriding assumptions: (1) that damage to coral would occur if trawling were conducted over it, (2) that damage to coral translates to a loss in economic benefits, and (3) that trawling presently occurs on coral. The validity of the first assumption appears rather strong. As indicated in the document, all gear types that could be used in coral reef habitats cause some degree of damage. Further, the validity of the second assumption appears to be rather strong given the known importance of coral to a healthy ecosystem and, hence, carrying capacity of some stocks. The validity of the final assumption appears to be more tenuous for at least two reasons. First, and primary, there appears to be little economic incentive for shrimp fishermen to trawl on coral since (a) shrimp are generally not abundant over coral and (b) costs to the shrimp fishermen, expressed in damage to the gear, would be large (see Section 3.5.2.1.1). As such, any trawling on coral is most likely accidental. Second, much of the coral bottom is already protected via regulations enacted in the Coral FMP. Given these two facts, one is left to conclude that actions to prohibit trawling over coral would provide, at most, relatively minor benefits to the nation.

While benefits associated with taking action to prohibit trawling on coral are likely to be minor, costs associated with such action, outside enforcement and monitoring, are also likely to be relatively small since displacement of shrimp fishermen from their ‘preferred’ fishing locations appears to be negligible. Finally, one is left with the question of how one would enforce and monitor an activity that is conducted only by accident. Specifically, the randomness (and infrequency) of such an activity suggests that adequate enforcement would be difficult and costly relative to possible gains.

The action ‘require aluminum doors on trawls’ would be required for trawling on hard bottom, SAV, and sand/soft sediments. As noted in 2.5.3, wooden doors tend to become waterlogged over time. If excessive, this could reduce trawling efficiency and, as such, fishermen tend to closely monitor the condition of the doors.

Aluminum doors tend to retain buoyancy much longer than wooden doors and therefore tend to have less tendency to drag or dig in, thus potentially reducing impacts slightly (Section 2.5.3). As further noted, many fishermen have voluntarily switched to aluminum doors during the past five years.

For benefits to accrue from the adoption of this action, damage to the targeted habitats must occur from the use of wooden doors. An assessment of the potential damage is provided in Section 3.5.2.1.1. As with coral, trawls do not generally operate on hard bottom due to damage it would cause to gear (see also Figure 3.3.8). Furthermore, to the extent that some activity may occur over hard bottom by accident, limited evidence provided by Mallinson suggests that short-term damage may be minor.

Similarly, evidence suggests that trawling over sand/soft sediments may result in only minor long-term disruptions though a number of caveats are noted; particularly with respect to cumulative impacts. However, trawls do have the potential to seriously impact sensitive habitat areas, such as SAV. However, SAV accounts for only a very minor proportion of habitat (less than two percent) and shrimp fishing effort over SAV appears to be very minor (see Figure 3.3.8; Shrimp trawl effort).[59]

Based on this discussion, benefits associated with the present action (requirement of aluminum doors) appear to be relatively minor. However, costs may also be relatively minor; particularly if

[59] It should also be noted that most if not all of the SAV is in state, rather than Federal, waters. Hence, regulations imposed by the Gulf of Mexico Fishery Management Council to protect essential fish habitat may have little or no impact with respect to SAV.

there is a phase-out period associated with wooden doors (i.e., as wooden doors deteriorate). This would be even more so if there is no loss in efficiency from switching to aluminum doors. The fact that fishermen have been doing it voluntarily during the past five years suggests that this may be the case. Finally, enforcement after the phase-out period would be relatively simple with little or no added costs.

The intent of limiting longlines to no longer than 6 miles and three sets/day (only on hard bottom since restrictions already keep longline off SAV) is to indirectly limit the effective amount of effort in the longline fishery (over hard bottom) and, hence, the amount of potential habitat damage. Potential damage from longlines is discussed in Section 3.5.2.1.6 though one is left with the impression that there is considerable uncertainty regarding benefits that might accrue.

As indicated in Figure 3.3.3, catches of reef fish using bottom longline gear tend to be relatively large in those grids that coincide with hard bottom habitat. Furthermore, based on NMFS logbook data (1990-2001), vessels using longline gear to catch reef fish averaged about 25 sets of 7.81 miles of longline per trip (Section 3.5.2.1.6). Based on NMFS 1995 observer data, the amount of mainline set at a location averaged 2.4 nautical miles and varied from less than one nautical mile to 9.0 nautical miles. Finally, the NMFS observer data indicated that 41% of the sets occurred over rock bottom.

The costs of adopting this action (limit longlines and sets per day) would depend upon the number of vessels currently exceeding these proposed measures. Based on NMFS observer data, some vessels apparently use longlines in excess of six miles and the profitability of these firms may be restricted via this action. If a participant was significantly impacted by this action, one might anticipate a modification in fishing practices by (a) changing to vertical gear or (b) moving longline practices to non-hard bottom habitat. Based on the information in Figure 3.3.3 (Reef fish bottom longline gear use), this later modification could be accomplished by either moving towards the beach (still remaining outside the longline boundary line) or by moving north into the predominant red grouper fishing grounds.

Unlike any of the other actions considered herein, requiring circle hooks and limiting sinker weight on all vertical lines (fishing on coral or hard bottom) would impact both commercial and recreational fishermen. With respect to commercial activities, the information contained in Figure 3.3.2 indicates that considerable reef fish vertical gear activities occur in association with coral and hard bottom habitat. This is further substantiated for recreational fishers by the information contained in Figures 3.3.12 and 3.3.13. According to testimony given before the Council, circle hooks are already being utilized by a large percentage of the commercial reef fish fleet. Use of circle hooks among recreational fishermen is probably less common than among commercial fishermen; the level of use, however, is unknown.

The costs associated with this proposed action, with respect to the commercial sector, would depend, primarily, upon: (a) the efficiency of standard, barbed hooks (J hooks) relative to circle hooks and (b) the loss in efficiency resulting from the proposed sinker weight limits. As mentioned, anecdotal information suggests that a sizeable proportion of commercial reef fish fishermen currently use circle hooks for reef fish fishing activities. This would suggest that the efficiency of circle hooks may equal, if not exceed, that of J hooks. If there is little difference in the efficiency between the two types of hooks, costs to the commercial sector associated with this proposed action would generally be minimal.   Costs to the recreational sector may also well be minimal. Specifically, use of circle hooks by recreational fishermen may be limited due only to a lack of information regarding their efficiency relative to the J hook. If this is the case, one might expect relatively costless adaptation by the recreational sector if required to do so. The limitations on sinker weights may make it more difficult for commercial and recreational fishers to fish efficiently in strong currents, but the extent to which this is true is not quantified.

With respect to the proposed sinker weight limits, costs may be relatively minor if most fishermen do not currently use sinkers in excess of the proposed weight limits. If the prevailing practice typically includes sinker weights in excess of the proposed limits, however, implementation of this regulation may result in a reduction in economic efficiency. Assuming fishermen are currently employing economically optimal fishing practices, the reduction in economic efficiency would translate to higher costs per unit of harvest. To some extent, fishermen may be able to circumvent the potential loss in efficiency if the weight limits are on a per sinker basis rather than in aggregate.

While costs may be relatively small (depending, to some extent, on sinker weights currently employed), the benefits are also likely to be relatively minor. As indicated in Section 3.5.2.1.9, vertical gears are considered to potentially have only a minor impact when used on coral reefs (and presumably hard bottom) though, as noted, fishing with vertical gear is usually concentrated over coral reefs, thus actual damage may be more than minimal.[60]   Much of the damage that could, in theory, occur to coral or hard bottom as a result of vertical fishing activities may not be the direct result of the hook but, instead, the sinker that comes in touch with the coral. Limitations on sinker weights may reduce this type of damage.

When retrieving the anchor it tends to drag across the bottom, thus potentially damaging different types of habitat. The placement of buoys on anchors reportedly reduces the amount of drag and, hence, potential damage.

The cost of these buoys is in the $45 to $60 range. This expense, in essence, would be a fixed cost with presumably no loss in fishing efficiency to either the commercial or recreational sector. If there is significant habitat damage resulting from the retrieving of anchors over sensitive habitats, the requirement that buoys be employed on anchors over these habitats (coral, hard bottom, and SAV) may yield relatively high benefits relative to costs. This conclusion, however, is predicated on: (1) that the dragging of anchors does result in significant damage, (2) that the placement of buoys on these anchors will significantly lessen the damage, and (3) that placement of the buoys does not impact the economic efficiency of fishing operations (both commercial and recreational).

With respect to Practicability factor, ‘net economic change to fishermen,’ the forgoing review of the individual actions included in the Alternative suggests that the benefits of some of the specific actions may exceed costs, though the level of uncertainty is substantial. For the actions taken in total, economic analysis does not allow one to conclude that benefits exceed costs, or

[60] The logic of this assertion may be debatable. Even if effort is very large, the cumulative impact may still be minor if each individual activity is negligible.

vice versa. This is primarily the result of a lack of specific information regarding potential benefits associated with the suite of actions as well as relatively little information regarding the costs that might be incurred.

4.3.6.2.2 Socio-economic impacts

As discussed under the economic impacts, the benefits to some actions may exceed costs. This means that social impacts of habitat recovery should be beneficial. However, in some cases the long term recovery of habitat may have further impacts. As mentioned with the preferred alternative, enforcing such regulations can become problematic and solutions to ensuring viable and effective enforcement can initiate other social impacts.

Changing doors on a trawl configuration may be more complicated than just mere replacement of wooden doors. Aluminum doors, because they are lighter, may require fishermen to change other aspects of their trawl configuration, like net type and type of mesh (nylon, poly), change float configuration or tickler chain and other characteristics. Changing the trawl configuration may mean further trials as catch rate may change also. With little information on costs and anticipated changes in other characteristics to the trawl configuration, it is difficult to completely determine the impacts of such an alternative. Depending upon the amount of changes that are required, which may be generated by factors included with bundled alternatives, the costs could be substantial which would impose some economic hardship. But how that translates into social impacts would be difficult to estimate. In contrast, if the costs are minimal and are merely the usual cost of replacing trawl doors and minor trawl reconfiguration then impacts would be nominal.

Using circle hooks will require increased costs associated with reconfiguring vertical lines and may reduce catch rates. However, circle hooks may reduce bycatch of certain species (Wilson and McCay, 1998) and therefore provide some increased efficiency.

Limiting bottom longlines to 6 miles in length and three sets per day on hard bottom will require reconfiguration of gear by reducing the length of some longlines. Without knowing the number of vessels that presently have longlines greater than six miles in length, the extent of that reconfiguration is not known. With the added impact of limiting vessels to three sets per day the impacts could be substantial if catch rates are reduced. Using circle hooks will again require increased costs associated with reconfiguring longlines and may reduce catch rates. However, circle hooks may reduce bycatch of certain species (Wilson and McCay, 1998) and therefore provide some increased efficiency. However, in their report, Wilson and McCay (1998) do report that the longline fleet has been facing declining prices which have in turn had a negative impact on fleet profitability. They further state that some within the longline fishing fleet see any further regulation of the fleet hastening the decline of an already diminishing fleet. They go on to point out that many longline vessels have begun to refit their vessels so they may participate in other fisheries, especially for other reef fish species like grouper. If the retrofitting of vessels to accommodate this bundled alternative is prohibitive, it is likely there will be considerable species switching, movement to other areas, or selling of vessels.

While Florida has a substantial amount of hard bottom and coral off of its coast, Florida communities are not the only ones affected as fishing vessels will travel around the Gulf to find good fishing locations. As Wilson and McCay (1998) have indicated, some longline vessels will make trips of over twenty days and travel from one end of the Gulf to another. While homeport is an important variable, fishing vessels may spend a substantial portion of their annual fishing in communities other than their homeport or the permit holder's home. This makes it difficult to fully measure impacts as both social and economic impacts may vary depending upon the vessel's location.

The communities that would be affected most by the first and second action of this alternative are primarily those with a substantial number of shrimp vessels and are listed in Section 3.3.2.7. These communities have been designated either very vulnerable or vulnerable in terms of employment opportunities and general quality of life indicators. If fishermen suffer substantial economic impacts it may be difficult for them to find alternative employment as these communities may not offer viable employment alternatives and may already suffer from high poverty rates and offer lower salary or wages. However, it is unlikely that these actions will result in such severe impacts to shrimp fishing communities.

Depending upon the cumulative impacts from this alternative, the communities that will be most affected by the third and fourth action are listed in Section 3.3.2.7 and Appendix G which list reef fish, swordfish and shark permits. These are communities that have substantial long line fishing activity as indicated by the presence of ten or more permitted vessels and are vulnerable according to the vulnerability index score. (See Appendix G for a full listing of communities with home ported Federally permitted vessels and Section 3 Human Environment for a listing of community vulnerability scores.) However, it is likely that most of the impacts will be at the vessel level as changes to gear are made and switching to other fisheries is considered as discussed under the economic impacts.

Requiring the use of buoys on all anchors may have few social impacts if it does not affect fishing patterns. The costs associated with outfitting a vessel may be substantial to the small boat owner, both commercial and recreational. The protection of coral in the long term may be more beneficial. It is impossible to determine communities that would be affected since this would also apply to private recreational fishing vessels and assigning these vessels to a community is not possible at this time.

With respect to the practicability factor 'equitability of costs among communities,' although it is difficult to fully measure impacts as both social and economic impacts as these vary depending upon the vessel's location and mobility, requiring aluminum doors on shrimp boats would affect all shrimpers located around the Gulf, but longline restrictions will have a greater impact on reef fish fishermen in Florida than other states.

4.3.6.3 Alternative 3

Alternative 3: Establish moderate modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 2, apply the following action items:

- Limit use of tickler chains to one chain with a maximum ¼ inch link diameter
- Limit total trawl headrope length to 180 feet or less
- Limit trawl vessels to 85 feet or less in length overall (LOA), and grandfather existing vessels
- Prohibit trotlines when using traps/pots

4.3.6.3.1 Economic Impacts

The actions considered in Alternative 3 include the five actions considered under the previous alternative plus four additional ones. The first three (limit the use of tickler chains to one chain, 1/4 inch, limit trawl headrope length, and limit vessel size) place additional restrictions on trawl fishing practices while the fourth action (prohibit trot lines when using traps/pots) would place additional restrictions on lobster and stone crab fishermen. These four additional actions are briefly discussed below:

Assuming that a significant proportion of vessels use tickler chains in excess of 1/4 inch, this action would act to reduce the technical efficiency of the fleet over all habitat types (other than coral where trawling would already be prohibited). Any significant reduction in technological efficiency would likely result in marginally profitable operations leaving the industry and other vessels moving into state waters, where possible, to avoid the increased restrictions. Interestingly though, however, producer surplus may not necessarily decline as a result of enactment of this action because, if significant, effective effort in the industry may decline and given the historically excessive amount of effort in the fishery, catch per unit effort among remaining vessels may be enhanced. In general, one would need to compare the change in revenues per unit effort (e.g., a 24 hour fishing day) to the increased costs per unit effort (a day fished). If revenues per day fished do increase, and this increase is in excess of the increased costs per day, producer surplus will not have fallen. Without a detailed analysis, however, there is no means of determining whether producer surplus will significantly decline (or possibly even increase, at least in the short term) as a result of this action.[61] With somewhat more certainty, however, one could probably conclude that such an action will not result in any long term increase in revenues generated from the shrimp industry. In fact, to the extent that this action results in significant movement of shrimp effort to state waters, total revenues will likely fall.[62]

Limiting total trawl headrope length to 180-feet or less, will, like the previous action, reduce the technological efficiency of the fleet if the proposed fishing restriction is binding on a portion of the fleet. Without considerably more analysis, however, it is impossible to state what the general

[61] Such a detailed analysis would require considerably more data than are currently available including the financial position of individual vessels in the fishery and changes therein related to implementation of the regulation.
[62] It does not necessarily follow from this that fleet profitability would fall since costs would also decline.

impact of this restriction would be on profitability (i.e., producer surplus of the fleet). As with the previous action, this action may direct some unknown amount of effort to state waters which could result in decreasing revenues and a further reduction in efficiency (i.e., catch per unit effort) among those vessels fishing in Federal waters.

Limiting total vessel length to 85-feet LOA or less would eliminate some vessels from the fleet (90- to 100-feet in length). These larger vessels can pull as many as 4 nets (total headrope length approximately 300 feet) and thereby contact more bottom habitat per time than smaller vessels.

Prohibit trot lines when using traps/pots (fishing on hard bottom or SAV): Based upon the information contained in Figure 3.3.9 (stone crab trap effort), the use of stone crab traps on either hard bottom or SAV appears to be rather limited[63], and relative impacts to hard bottom are low compared to coral (Figure 3.5.24). This is even more the case with respect to lobster traps (Figures 3.3.10 and 3.5.25). To the extent that these figures are accurate, one can conclude that little or no benefits would accrue from the prohibition of trot lines when using traps/pots.[64]

Given the relatively small usage of traps/pots on hard bottom and SAV, the costs associated with the proposed action are also likely to be relatively minor. The additional enforcement requirements might indicate, however, that the total costs of the proposed action exceed any benefits derived there from.

As with Alternative 2, there is insufficient information to determine whether the benefits of the proposed actions included in Alternative 3 exceed the costs. All that can be stated with some certainty is that one would anticipate costs to increase as additional restrictions are placed on current fishing practices (due to reduced efficiency). However, benefits might also be enhanced, assuming fishing practices generate negative externalities (over and above those due to the common property nature of many of the fishery resources; i.e., one fisherman's activities negatively impacting the welfare of another fisherman via competition for the limited resource).

With respect to 'net economic change to fishermen,' one practicability factor, a detailed economic analysis of the costs and benefits would require considerably more information than is currently available. First, one would need a quantitative estimate of the impact on essential fish habitat resulting from different amounts of gear usage (by type of gear). Second, one would need an economic estimate of benefits associated with protection and/or enhancement of the different habitats (i.e., changes in welfare to society at different levels of essential fish habitat). Third, one would need estimates of the change in fishing practices resulting from implementation of the regulation and the change in costs in relation to the changes in fishing practices. None of this information is currently available and the costs of collecting/estimating it would be exorbitant.

[63] Furthermore, as noted in the document, most stone crab activities occur in state rather than Federal waters.

[64] Since trotlines are generally not employed with fish trap activities, this gear is not considered in this action.

4.3.6.3.2 Socio-economic impacts

The discussions regarding exclusion zones, changing to aluminum doors, longlining limits, circle hooks, and buoys on anchors from Alternative 2, apply here as well.

Shrimp fishermen in the Gulf of Mexico have been experimenting with net and door configurations for decades. The trawling configuration for a particular vessel may include one, two or four nets of varying length, depending upon the size of vessel, engine size and other vessel characteristics. Requiring smaller net configurations through limiting headrope length could have significant impacts on the profitability of operating large vessels. Pulling smaller net configurations could impose inefficiencies that may affect overall profit for the vessel, which in the end may make it impractical to continue using larger vessels in the Gulf shrimp fishery. Owners may be forced to sell the vessel rather than use a smaller net configuration or may try to refit the vessel for entry into another fishery or move to another location.

If vessel owners sell their vessels and do not buy a vessel that can more efficiently pull a smaller net configuration, then crew and possibly hired captains will be out of work. Furthermore, those support industries such as net makers, door manufacturers, fuel depots and seafood dealers and processors will also endure negative impacts from the loss of business. For those who can refit their vessels with smaller net configurations, the impacts will be less, but there may be short-term impacts as owners purchase new nets or reduce the size they presently have.

For those with larger vessels, the impacts will depend upon their ability to refit their vessel for another fishery or sell the vessel. A grandfather clause would allow larger vessels to remain, but it can not be determined if they can survive given the limitation on net size. Buying a new vessel and remaining in the fishery is an option. Although fishermen have long been attached to their occupation, many feel the industry is declining to a point where it is too difficult to remain in it, especially in the face of increasing regulation. The regulatory burden, added to other forces, such as the cost price squeeze from an increasingly competitive market are forcing many to tie up their boats and seek alternative employment.

Prohibiting the use of trotlines will require some vessels in the trap fishery to reconfigure their vessels. This may reduce the efficiency of their fishing operation and add costs to operating budgets as they will have to add floats and other gear to adapt to another fishing method.

With respect to 'equitability of potential costs among communities,' those communities that would be most affected if the costs of reconfiguration in actions one, two, three and four are prohibitive are listed in Section 3.3.2.7. These communities have been designated either very vulnerable or vulnerable in terms of employment opportunities and general quality of life indicators and they have ten or more permitted shrimp vessels. For action five, the prohibition on trotlines, those communities most affected would be those listed under the lobster permit table (Appendix D).

4.3.6.4 Alternative 4

Alternative 4: Establish major modifications to fishing gears and gear closures on sensitive habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 3, apply the following action items:

- Limit total trawl headrope length to 120 feet or less
- Limit trawl vessels to 81 feet or less LOA on hard bottom or SAV
- Prohibit use of tickler chains on hard bottom
- Prohibit use of all traps/pots and bottom longlines and buoy gear on coral
- Prohibit all use of anchors on coral, and require use of mooring buoys if vessels need to "anchor" or maintain a stationary position

4.3.6.4.1 Economic Impacts

Limiting total trawl headrope length to 120-feet or less and vessels to 81-feet or less LOA on hard bottom or SAV would be similar to Action 2 under Alternative 3, but more restrictive. The same general conclusions, however, would apply.

Prohibiting use of tickler chains (fishing on hard bottom, SAV, and sand/soft sediments) would, based on available information, impose significant economic costs on the shrimp fleet. Virtually all of the shrimping activities in the EEZ is trawl based and the efficiency of harvesting both brown and pink shrimp would be considerably diminished if the use of tickler chains on these different bottom types, particularly sand/soft sediments were curtailed (evidence suggests that trawling activities on hard bottom and SAV is very limited). This would likely result in movement by some vessels to state waters in an effort to avert such regulation, but this would likely be limited primarily to the smaller vessels. In general, one could state that the economic costs associated with this action would be significant. Having said this, however, one cannot necessarily conclude that the costs of taking such action exceed benefits. One would conclude, however, that benefits would need to be relatively large for this action to show positive net economic benefits.

Stone crabs and lobster are often associated with coral formations as indicated in Figures 3.3.9 and 3.3.10. Prohibiting use of all traps/pots and bottom longlines and buoy gear on coral might cause relatively high dislocation costs, particularly if the restriction included state waters. While costs may be relatively high, if pots/traps do seriously impact coral, potential economic benefits associated with this restriction may also be high. However, traps are generally not placed on coral but, rather, close to coral. Hence, one might anticipate that most damage is from accidental placement and/or the result of external forces (e.g., storms that move traps). While still important, it does suggest that potential costs are lower than what would be the case if traps/pots were placed directly on coral.

While the other actions in Alternative 4 focus on commercial fishing, the prohibition if all use of anchors on coral, and requirement to use mooring buoys if vessels need to "anchor" or maintain a stationary position would restrict recreational fishermen and divers. Without quantitative knowledge of the damage caused by anchors and the cost of taking remedial action, it is not possible at this time to determine whether benefits from taking the action would exceed costs.

The costs associated with implementation of Alternative 4 would be, almost certainly, significantly higher than those under Alternative 3. However, if there are large negative externalities associated with the use of certain fishing gears on various habitats, the benefits derived from implementation of the actions included in Alternative 4 would exceed those in Alternative 3. Given the paucity of biological, habitat (including gear damage), and economic information, however, one can reach no conclusions regarding the relative benefits and costs associated with implementation of the various actions.

To adequately address Alternative 4 from a benefit/cost perspective, one would need to conduct a significant amount of additional analysis. First, one would need to ascertain the impact of the different gears on the different essential habitats. One would then have to translate changes in habitat to changes in stock size. Then, one would need to estimate changes in producer and consumer surplus resulting in changes in stock size. Finally, one would need to estimate economic losses/gains from non-consumptive activities. Thus is it not possible to definitively determine the net economic change to fishers of this Alternative.

4.3.6.4.2 Socio-economic impacts

The discussion of social impacts for previous alternatives covers the options included in Alternative 4 except the use of mooring buoys. Restrictions on anchoring on coral, and the requirement to use a mooring buoy as the only option to anchor, may increase conflict among various user groups such as private recreational, charter/headboat and commercial fishermen who would all likely use these moorings and compete for their use in coral habitats. However, with respect to equity (one practicability factor), those communities most likely to be affected are in Monroe County, FL (Marathon to Key West) near the Tortugas Ecological Reserves, along the Central Texas coast from Corpus Christi to Galveston from which fishermen depart for the Flower Gardens Banks, and Pinellas (Madeira Beach, Tarpon Springs) and potentially Bay counties (Panama City), FL, where folks depart for the Florida Middle Grounds (Appendix G).

4.3.6.5 Alternative 5.

Alternative 5: Prohibit gears and fishing activities that have adverse impacts on EFH from the EEZ. Apply the following action items:

- Prohibit use of all bottom trawling gear
- Prohibit use of all traps and pots
- Prohibit use of all bottom longline & buoy gear
- Prohibit use of all spears and powerheads
- Prohibit use of all vertical gear
- Prohibit use of all anchors

4.3.6.5.1 Economic impacts

Alternative 5 would prohibit the use of a large number of gears over a variety of habitats. Without going into detail, it is obvious that the costs associated with this 'bundle' of actions would be very large. In the short term, it would almost certainly result in a significant reduction in net economic benefits to the commercial fishing sector (likely driving them close to zero) and it appears likely that even the long-run benefits to the sector would be less than under the No Action alternative. Similarly, the reef fish component of the recreational sector would likely experience a reduction in consumer surplus in the short term, and possibly the long term, as a result of enactment of this alternative.

Virtually all shrimp catch from Federal waters is trawl based. Without any technological or economically efficient alternatives, one would anticipate that: (a) many of the larger vessels unable to avert the restrictions by altering fishing practices would exit the fishery, and (b) other [generally smaller] vessels would attempt to avert the restrictions in Alternative 5 by moving to state waters, where possible. Movement of a large number of vessels to state waters would, without question, significantly increase crowding externalities. In addition to the increased crowding externalities, increased effort and catch from state waters would have other, far reaching, impacts. First, since a smaller size of shrimp would be harvested, on average, total industry revenues (though not necessarily profits) would decline. Second, the smaller shrimp being harvested would likely result in changes in the processing sector. For example, "larger" shrimp is generally simply frozen and boxed while the "smaller" shrimp is used in peeling. The increased harvest of smaller shrimp, therefore, may translate into an evolution of the processing industry to enhanced peeling activities. This would come at a time when foreign countries are increasingly producing value added (particularly peeled) product destined for the U.S., European, and other markets. Finally, support industries that have developed to assist the larger vessels would be impacted.

With respect to other commercial fisheries, such as the reef fish fishery, prohibition of bottom longline and buoy gear on hard bottom and coral, and prohibition of vertical line on hard bottom would, for all practical purposes, result in a complete cessation of longlining activities. To the extent possible, many of these longline boats would attempt to convert to vertical line. These boats and the traditional vertical line boats would likely, to a large extent, move to state waters resulting in increased harvest of undersized reef fish, increased congestion externalities, and exacerbated conflicts with the recreational sector. Such action would almost certainly result in a reduction in producer surplus and also, likely, consumer surplus.

While most of the discussion to this point has focused on the commercial harvesting sector, the recreational sector also uses vertical gear in the Federal waters when targeting certain species, such as reef fish. This component of the recreational sector would almost certainly experience a reduction in consumer surplus in the short run, and likely the long run, as a result of enactment of Alternative 5. Furthermore, to the extent that the recreational effort shifts to state waters, there would likely be increased discarding and mortality of undersized fish and increased crowding externalities.

There may, however, be two primary beneficiaries associated with implementation of Alternative 5. First, non-consumptive users may benefit if implementation of Alternative 5 does result in protection/enhancement of essential fish habitat. Similarly, individuals "willing to pay" for the existence of a pristine habitat (independent of using the habitat) would benefit.

Overall, one would have to conclude that the benefits would have to be very large to justify Alternative 5 from an economic efficiency point of view (external costs directly related to the amount of damage to essential fish habitat caused by fishing gear and the economic benefits derived from this habitat must be very large). As noted in the introduction, a certain amount of habitat degradation is usually permissible under the concept of economic efficiency, the exact amount dependent upon the divergence of marginal private and marginal social costs. From a practicability perspective, the net economic costs of this Alternative to fishermen are not outweighed by the environmental benefits.

4.3.6.5.2 Socio-economic impacts

A prohibition of trawling gear in the EEZ would have a significant impact upon the Gulf shrimp fishing industry. Because the impact of this alternative is so severe, it is important to understand the context within which this and other alternatives are considered as the social impacts come from not only action taken, but action considered, as perceptions are also part of social impacts.

Gulf shrimp fishermen have recently complained that they are already under duress facing lower prices because of imports and new and impending regulations (Babier, 2002 and Fiorillo, 2002). In fact, there have been bills introduced in Congress that would address the problem of "dumping" on the shrimp market by foreign producers and also the selling of shrimp that may contain the chemical chloramphenicol.

If it is true that shrimp fishermen are already under duress, it may be that they are burdened with a significant portion of our nation's priority to protect habitat and endangered species. The prices they receive for their shrimp will not respond normally to the increased costs they incur from shrimp fishing. This is called a cost price squeeze by economists. Shrimp fishermen in other countries are not held to the same environmental and health standards. They are not all required to place TEDs or BRDs in their nets, may be able to use chemicals to preserve their shrimp that are prohibited in the United States, may be subsidized by their government, and/or utilize labor that is much cheaper than in the United States. Given these advantages, it may be difficult for Gulf shrimp fishermen to compete with imported shrimp.

Consequently, because a large portion of shrimp consumed is imported, the American consumer is receiving a product that does not reflect all of the costs that are imposed upon American shrimp fishermen. In one sense, standards of environmental and human health have been imposed on the harvesting of shrimp in the United States, but, the product that is being consumed by most Americans does not reflect the entire cost of those standards. This brings into question the social equity of continuing to impose the burden of environmental protection on American shrimp fishermen who have already endured increased regulation in this area and are facing new regulations with regard to sea turtle protection. Shrimp fishermen see this as an injustice and would like to see their competitors bear some of this burden to help free them from the cost price squeeze they must now endure.

Cross-culturally fishermen share a strong sentiment toward their work. It is often seen more as a livelihood than a job and is something of a time-honored tradition that is "in their blood" (Acheson, 1981). Fishermen may still want to fish for a living, so a complete ban on trawling would then become a matter of shifting effort to another fishery. Entering another fishery is not as easy as it once was since fishery management agencies have increasingly utilized limited entry systems to address overcapitalization and to reduce effort. Furthermore, entry into fisheries without limited entry may create situations where overcapitalization may occur.

With respect to 'equity of potential costs among communities' (practicability), prohibiting the use of bottom longline gear & buoy gear, vertical gear, powerheads, and anchors on all but sand and soft sediment will likely have significant impacts across the commercial and recreational fishing fleet. In many cases, it is likely that such prohibitions will require vessel owners to either sell their vessel or move to another location where they are able to continue fishing with their currently configured vessels. If they are unable to move and are forced to sell vessels and can no longer participate, the social impacts would be significant as owners, captains and crew would likely have to seek alternative employment. In addition, vital support industries that supply vessels with gear, fuel, repairs and groceries would be impacted as with the shrimp industry mentioned earlier.

The list of communities that would be most affected are those which have vessels from the several different fisheries that are impacted by these actions. The communities of Madeira Beach, Panama City, Pensacola, Tampa, Apalachicola, Marathon, Carabelle, Grand Isle, Orange Beach, St. Petersburg, and Venice are a few of the communities that will likely be affected as listed under Section 3.3.2.7. However, it is important to understand that even within this list of communities the impacts will vary depending upon a number of factors. Factors such as relative placement on a rural and urban continuum can be an important factor as job opportunities in rural areas are far fewer than in urban areas. Furthermore, resources for those who require some type of welfare or assistance are usually better in urban areas. In addition, those communities which are heavily dependent upon one type of fishing activity, whether it be directly though fishing vessels and their linkages throughout the community or processing and the impact on employment and income, may have significant impacts even though they are limited to one fishery.

It is quite likely that most fishing communities would have significant impacts as the fishing industry and supporting businesses see important reductions in revenues as a result of this bundled action. Impacts on communities would likely be increases in the number of unemployed or declines in population as people move to other areas to find work. Over time, the culture and folkways of some communities may change as these former fishing communities are transformed to another form of economic base. While many fishing communities may already be in the midst of transitions to an economy based upon recreation and tourism, such actions as those included in this alternative would hasten such a transition.

4.3.6.6 Alternative 6 (Preferred Alternative)

Alternative 6 (Preferred Alternative): Establish minor modifications to fishing gears and gear closures on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- Regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs
- Prohibit bottom anchoring over coral reefs in HAPCs
- Prohibit use of bottom longlines, buoy gear, and all traps/pots on coral reefs
- Prohibit the use of trawling gear on coral reefs
- Require a weak link in the tickler chain of bottom trawls on all habitats

4.3.6.6.1 Economic impacts

The Preferred Alternative 6 contains five regulatory measures. The first measure would regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs.[65] There is no indication, however, at this time what the maximum weight would be. If it is above that employed by most commercial and recreational fishermen, the costs of imposing the regulation would likely be small and would approach zero if the maximum weight is above that used by all vertical line participants. Conversely, as the percentage of participants impacted by the weight limit increases, costs, at least in the short run, will also increase. The costs are a result of reduced economic efficiency in the use of "preferred" gear. In the long run, however, the reduction in economic efficiency may be reduced if protection (and possible future enhancement) of coral reefs in HAPCs translates into increased stock sizes of species dependent on coral reefs. The increased stock sizes, in turn, would translate into increased catches per unit effort.

While costs associated with regulating sinker weight will be small (or zero) if only a small percentage of participants are affected, benefits are likely also to be minimal (or zero). Benefits will increase as more participants are affected, however, if: (a) "heavy" sinkers do result in degradation of coral reefs in HAPCs and (b) the degradation results in a decline in the size of fish stocks or a reduction in non-use value associated with the coral reef, such as existence value. To quantitatively measure benefits, however, one would first need to know: (a) the impact of "heavy" sinkers on coral reefs in HAPCs, (b) how this impact translates into changes in stock size and/or non-use values, and (c) changes in consumer/producer surplus resulting from changes in stock sizes and/or non-use activities.

The second measure would prohibit bottom anchoring over coral reefs in HAPCs. Benefits associated with adoption of this action would accrue in the form of protection of coral reefs in HAPCs. As with the previous action, however, benefits will only accrue if (a) anchoring over coral reefs in HAPCs is significant and results in degradation and (b) degradation results in reduction in the size of fish stocks and/or non-use values. In general, available information does

[65] One might ask how this action could be reasonable enforced. While beyond the scope of discussion, it is likely that enforcement costs would greatly exceed benefits. Specifically, those individuals knowingly violating the maximum weight limits could easily cut his/her line at the sight of enforcement. This would indicate that the majority of those apprehended did not know of the regulation.

suggest that anchors cause damage and can result in a reduction in ecosystem services provided by coral reefs. Without additional detailed information, however, there is no means by which to establish even a range of possible benefits.

The costs associated with this action depend upon the extent to which anchoring currently occurs over coral reefs in HAPC's and what substitutes are available. This information is currently unknown.

The third measure would prohibit use of bottom longlines, buoy gear, and all traps/pots on coral reefs. Stone crabs and lobsters are often associated with coral formations. Traps, however, are not generally placed directly on coral but, rather, close to coral. To the extent that this statement is accurate, dislocation costs would likely be relatively minor. This is particularly true given the fact that most stone crab activities occur in state waters which would not be subject to this measure. If lobster traps are often placed on coral reefs, however, dislocation costs would increase proportionately. While costs may be relatively high in this case, potential benefits may also be large, assuming if they seriously impact coral. Overall, one might anticipate that that most damage is the result of accidental placement and/or the result of external forces (e.g., movement of traps as a result of storms). While still important, it does suggest that potential costs are lower than what would be the case if traps/pots were intentionally placed directly on coral.

Restriction of bottom longlines and buoy gear on coral reefs would result in dislocation costs if there is a significant amount of this activity. However, benefits would also accrue if the gear causes any significant amount of degradation to the coral reefs. Without additional information, including the extent of longlining activities on coral reefs and damage resulting from the activity, however, there is no means of determining whether the benefits associated with enactment of the measure would exceed costs.

Measure 4 would prohibit the use of trawling gear over coral reef. The intent of this action is to protect the coral resources from damage associated with trawling activities. The premise that benefits would accrue from such action is, of course, conditioned on three primary assumptions: (a) that damage to coral would be forthcoming if trawling were conducted on it, (b) that damage to coral translates to a loss in economic benefits, and (c) that trawling presently occurs on coral. The validity of the first assumption appears to be convincing. As discussed in detail in Section 3.5.2.1, all gear types that could be used on coral reef habitats cause some degree of damage. Further, the validity of the second assumption appears to be strong given the known importance of coral to a healthy ecosystem and, hence, carrying capacity of some stocks. The validity of the final assumption appears to be somewhat more tenuous for at least two reasons. First, and primary, there appears to be little economic incentive for shrimp fishermen (the primary fishery using trawls) to trawl on coral reef since (a) shrimp are generally not abundant over coral and (b) costs to the shrimp fishermen, expressed in damage to gear, would be large. As such, any trawling on coral would most likely be accidental. Second, much, but not all, of the coral bottom is already protected under regulations enacted in the Coral FMP. Areas under current study, such as Pulley Ridge, may be classified as coral in the near future, however the extent of potential coral habitat is unknown at this time. Given these two facts, the actions to prohibit trawling over coral would provide relatively minor economic benefits to the nation.

While benefits associated with taking action to prohibit trawling on coral are likely to be minor, costs associated with such action, outside monitoring and enforcement, are also likely to be relatively minor since displacement of shrimp fishermen from their “preferred” fishing location appears to be negligible. Finally, one is left with the question of how one would enforce and monitor an activity that is conducted only by accident. Specifically, the randomness (and infrequency) of such an activity suggests that adequate enforcement would be difficult and costly relative to possible gains.

Measure 5 would require a weak link in the tickler chain of bottom trawls on all habitats. Certainly, a very weak link would minimize any habitat degradation. This would translate into benefits if trawling does cause any significant damage and if this damage translates into changes in the size of fish stocks. However, it could also be costly to the trawling fleet since it would result in loss of catch associated with tows where the weak link breaks. The ‘stronger’ the weak link, the lower would be the costs to the commercial fishing sector. Likewise, however, benefits would proportionately be reduced. More research would be needed to fully assess costs and benefits.

In summary, this Alternative is likely to provide economic benefits to the nation. However, to determine definitively if these benefits exceed costs would require considerably more detailed analysis, including: (a) a quantitative estimate of damage caused by gears, (b) the impact of this damage on the size of fish stocks, and (c) changes in producer and consumer surplus, would be required before any more definitive analysis of benefits and costs could be presented.

Yet, this Preferred Alternative is the most practicable compared to all other alternatives.

4.3.6.6.2 Socio-economic impacts

The social impacts from the preferred alternative fall somewhere between those associated with the No Action alternative and the more restrictive alternatives that require gear modification and area closures. The modification of gear included within this alternative seems minor and any social impacts that would follow would generally be considered nominal if any. While coral reef habitat can be identified, yet the extent that the prohibitions included in this alternative would impact fishing practices is not entirely clear. However, some of the extended social impacts are discussed under Section 4.4.6 Administrative Impacts.

The communities that would be affected most by this alternative are those with reef fish and shrimp vessels. Those communities that would be most vulnerable are listed in Section 3.3.2.7. It is important to recognize that some communities with *both* reef fish vessels and shrimp vessels are potentially more vulnerable because under this action (i.e., communities in the Florida Keys). However, it is also important to recognize that coral habitat in the entire Gulf of Mexico is very small compared to all fishable areas, they are scattered around the Gulf, and most are already closed to the type of gears listed in this Alternative. Thus, it is unlikely that any community will be very dependent upon fishing on coral habitat, and unduly impacted.

4.3.6.7 Alternative 7

Alternative 7: Establish some minor modifications to fishing gears and one major gear closure on sensitive live hard bottom habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. The actions include:

- Limit bottom longline sets to 5 miles in length, and to three sets/day
- Prohibit trotlines when using traps/pots
- Prohibit all anchoring
- Enact a seasonal closure for shrimp trawl fishing

4.3.6.7.1 Economic impacts

The intent of limiting longlines to no longer than 5 miles and three sets/day (only on hard bottom since restrictions already keep longline off SAV) is to indirectly limit the effective amount of effort in the longline fishery (over hard bottom) and, hence, the amount of potential habitat damage. Potential damage from longlines is discussed in Section 3.5.2.1.6 though one is left with the impression that there is considerable uncertainty regarding benefits that might accrue by trying to reduce this potential damage.

As indicated in Figure 3.3.3 catches of reef fish using bottom longline gear tend to be relatively large in those grids that coincide with hard bottom habitat. Furthermore, based on NMFS logbook data (1990-2001), vessels using longline gear to catch reef fish averaged about 25 sets of 7.81 miles of longline per trip (Section 3.5.2.1.6). Based on NMFS 1995 observer data, the amount of mainline set at a location averaged 2.4 nautical miles and varied from less than one nautical mile to 9.0 nautical miles. Finally, the NMFS observer data indicated that 41% of the sets occurred over rock bottom.

The costs of adopting this action (limit longlines and sets per day) would depend upon the number of vessels currently exceeding these proposed measures. Based on NMFS observer data, some vessels apparently use longlines in excess of five miles and the profitability of these firms may be restricted via this action. If a participant was significantly impacted by this action, one might anticipate a modification in fishing practices by (a) changing the ratio of hooks per mile of gear, (b) changing to vertical gear or (c) moving longline practices to non-hard bottom habitat. Based on the information in Figure 3.3.3 (Reef fish bottom longline gear use), this later modification could be accomplished by either moving towards the beach (still remaining outside the longline boundary line) or by moving north into the predominant red grouper fishing grounds.

Prohibiting trot lines when using traps/pots (fishing on hard bottom or SAV): Based upon the information contained in Figure 3.3.9 (stone crab trap effort), the use of stone crab traps on hard bottom appears to be rather limited[66], and relative impacts to hard bottom are low compared to coral (Figure 3.5.24). This is even more the case with respect to lobster traps (Figures 3.3.10 and

[66] Furthermore, as noted in the document, most stone crab activities occur in state rather than Federal waters.

3.5.25). To the extent that these figures demonstrate, one can conclude that little or no benefits would accrue from the prohibition of trot lines when using traps/pots.[67]

Given the relatively small usage of traps/pots on hard bottom, the costs associated with the proposed action are also likely to be relatively minor. The additional enforcement requirements might indicate, however, that the total costs of the proposed action exceed any benefits derived therefrom.

Benefits associated with the measure to prohibit bottom anchoring associated with fishing activities would accrue in the form of protection for fish habitats, especially for live hard bottom. As with the previous action, however, benefits will only accrue if (a) anchoring over live hard bottom is significant and results in degradation and (b) degradation results in reduction in the size of fish stocks and/or non-use values. In general, available information does suggest that anchors can cause damage and result in a reduction in ecosystem services provided by live hard bottom. Without additional detailed information, however, there is no means by which to establish even a range of possible benefits. The costs associated with this action depends upon the extent to which anchoring currently occurs over live hard bottom habitats. This information is unknown.

The seasonal prohibition on the use of trawling gear over live hard bottom is intended to protect the live hard bottom resources from damage associated with trawling activities. The premise that benefits would accrue from such action is, of course, conditioned on three primary assumptions: (a) that damage to hard bottom would be forthcoming if trawling were conducted on it, (b) that damage to live hard bottom translates to a loss in economic benefits, and (c) that trawling presently occurs on live hard bottom. The validity of the first assumption appears to be convincing. As discussed in detail in Section 3, trawls used on live hard bottom habitats cause a moderate degree of damage. Further, the validity of the second assumption appears to be strong given the known importance of live hard bottom to a healthy ecosystem and, hence, carrying capacity of some stocks. The validity of the final assumption appears to be somewhat more tenuous. There appears to be little economic incentive for shrimp fishermen (the primary fishery using trawls) to trawl on live hard bottom since (a) shrimp are generally not abundant over live hard bottom and (b) costs to the shrimp fishermen, expressed in potential damage to gear from snags and tears, would exceed the benefits. As such, any trawling on live hard bottom would most likely be accidental. Given this fact, the actions to prohibit trawling over live hard bottom would provide relatively minor economic benefits to the nation.

While benefits associated with taking action to prohibit trawling on live hard bottom are likely to be minor, costs associated with such action, outside monitoring and enforcement, are also likely to be relatively minor since displacement of shrimp fishermen from their "preferred" fishing location appears to be negligible, as is seen in the fishing effort data provided in Figure 3.5.23b. Finally, one is left with the question of how one would enforce and monitor an activity that is conducted infrequently or by accident. Specifically, the randomness of such an activity suggests that adequate enforcement would be difficult and costly relative to possible gains. It would likely only be possible with the use of VMS, for which there are additional costs to both the individual fishermen and the NOAA Enforcement. The Gulf Council intends to incorporate the

[67] Since trotlines are generally not employed with fish trap activities, this gear is not considered in this action.

use of VMS in future regulatory actions, particularly related to both the Shrimp and Reef Fish FMPs (Council motion, May 2003), but full costs analyses have not yet been conducted. Systems can vary greatly and costs to individual fishermen can be a low as several hundred dollars for rather simple systems (with one way transmission) up to several thousand dollars for systems that allow two-way transmission.

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With respect to Practicability factor, 'net economic change to fishermen,' the forgoing review of the individual actions included in the Alternative suggests that the benefits of some of the specific actions may exceed costs, though the level of uncertainty is substantial. For the actions taken in total, economic analysis does not allow one to conclude that benefits exceed costs, or vice versa. This is primarily the result of a lack of specific information regarding potential benefits associated with the suite of actions as well as relatively little information regarding the costs that might be incurred.

4.3.6.7.2 Socioeconomic impacts

As discussed under the economic impacts, the benefits to some actions may exceed costs. This means that social impacts of habitat recovery should be beneficial. However, in some cases, the long term recovery of habitat may have further impacts. As mentioned with the preferred alternative, enforcing such regulations can become problematic and solutions to ensuring viable and effective enforcement can initiate other social impacts.

Limiting bottom longlines to 5 miles in length and three sets per day on hard bottom will require reconfiguration of gear by reducing the length of some longlines. Without knowing the number of vessels that presently have longlines greater than five miles in length, the extent of that reconfiguration is not known. With the added impact of limiting vessels to three sets per day the impacts could range from being substantial if catch rates are reduced, to negligible, if the majority of vessel operators currently use a configuration close to 5 mile lengths. In their report, Wilson and McCay (1998) do report that the longline fleet has been facing declining prices which have in turn had a negative impact on fleet profitability. They further state that some within the longline fishing fleet see any further regulation of the fleet hastening the decline of an already diminishing fleet. They go on to point out that many longline vessels have begun to refit their vessels so they may participate in other fisheries, especially for other reef fish species like grouper. If the retrofitting of vessels to accommodate this bundled alternative is prohibitive, it is likely there will be species switching, movement to other areas, or selling of vessels.

While Florida has a substantial amount of hard bottom and coral off of its coast, Florida communities are not the only ones affected as fishing vessels will travel around the Gulf to find good fishing locations. As Wilson and McCay (1998) have indicated, some longline vessels will make trips of over twenty days and travel from one end of the Gulf to another. While homeport is an important variable, fishing vessels may spend a substantial portion of their annual fishing round in communities other than their homeport or the permit holder's home. This makes it difficult to fully measure impacts as both social and economic impacts may vary depending upon the vessel's location.

Prohibiting the use of trotlines will require some vessels in the trap fisheries to reconfigure their vessels. This may reduce the efficiency of their fishing operations and add costs to operating budgets as they will have to add floats and other gear to adapt to another fishing method.

Restrictions on anchoring, would require the use of a mooring buoy as the only option to anchoring. This might increase conflict among various user groups such as private recreational, charter/headboat and commercial fishermen who would all likely use these moorings and compete for their use in coral and other habitats.

The communities that would be affected most by the seasonal closure of live hard bottom areas to shrimp trawling are primarily those with a substantial number of shrimp vessels and are listed in Section 3.3.2.7. However, due to the relatively low level of shrimp fishing activity off the coast of Florida, as compared to the western parts of the Gulf, the likelihood is that Florida communities will be more affected than those in Louisiana and Texas, regions with higher numbers of active shrimp fishing vessels.

Generally, the Louisiana and Texas communities with a substantial number of shrimp vessels have been designated either very vulnerable or vulnerable in terms of employment opportunities and general quality of life indicators. If fishermen from these communities suffer substantial economic impacts it may be difficult for them to find alternative employment as these communities may not offer viable employment alternatives and may already suffer from high poverty rates and offer lower salary or wages. However, the majority of Florida communities have been designated as somewhat vulnerable to not vulnerable, thus it is unlikely that these actions will result in severe impacts to these shrimp fishing communities.

With respect to the practicability factor ‘equitability of costs among communities,” although it is difficult to fully measure impacts as both social and economic impacts as these vary depending upon the vessel’s location and mobility, longline restrictions will have a greater impact on reef fish fishermen in Florida than other states, and the prohibition on trotlines, would most affect those communities listed under the lobster permit table in Florida (Appendix D).
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4.3.7 Consequences for the administrative environment

There should be limited to no direct or indirect impacts on Federal agencies other than NOAA and the US Coast Guard which facilitates NOAA Fisheries enforcement efforts through the implementation of any of these alternatives. Only Alternative 5 may have significant impacts on state fishery management. These regulations to implement EFH designation and protections will be reviewed by the Council every 5 years.

4.3.7.1 Alternative 1 (No Action/Status Quo)

Alternative 1 (No Action/Status Quo): Use existing regulations to prevent, mitigate, or minimize adverse fishing impacts in State and Federal waters of the Gulf of Mexico.

Under this alternative no new measures to prevent, mitigate or minimize potential adverse impacts on EFH from fishing would result and therefore may not meet the requirements of the M-S Act. Federal and State measures that currently in place would remain in effect and offer some degree of protection. Current levels of enforcement would continue.

With respect to practicability factor 'effect on enforcement, management and administration,' Alternative 1 would require no amendments to the Gulf of Mexico FMPs, and thus no changes to the current regulatory process.

4.3.7.2 Alternative 2

Alternative 2: Establish minor modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- No bottom trawling over coral
- Require aluminum doors on trawls
- Limit bottom longline sets to 6 miles in length, limited to three sets/day on hard bottom
- Require circle hooks on all vertical lines and allow maximum sinker weights of 2 pounds on bandit rigs and 0.5 pounds on rod and reel, electric rigs, and handlines
- Require use of buoys on all anchors

Under this alternative there would be an increased level of administrative and enforcement effort by NOAA Fisheries above no action (Alternative 1), but somewhat less enforcement effort than Alternative 5.

Management measures dealing with trawling would apply only to the Shrimp FMP, measures dealing with bottom longlines would apply only to the Reef Fish FMP, measures dealing with circle hooks and sinker weights would apply to the Red Drum, Reef Fish, and Coastal Pelagics FMPs, and use of buoys on anchors would apply to Reef Fish, Coastal Migratory, Spiny Lobster, and Coral FMPs.

Enforcement requirements would increase, and some measures of Alternative 2 are difficult to enforce. It would be possible to inspect commercial fishing vessels to ensure compliance with aluminum doors, just as they currently inspect for compliance with the use of proper TEDs and BRDs. Similarly, it might be possible to measure longlines during a boarding inspection, however, it would not prevent fishermen from potentially stringing more than one line together while actively fishing. This type of gear restriction is best when paired with requiring the use of vessel management systems (VMS). When calibrated properly, VMS systems can measure active fishing effort through monitors on engines, winches, and distance traveled.

It would be quite difficult for enforcement officers to observe fishing activities on board to assure compliance with use of circle hooks, maximum weights, or buoys on anchors, and the benefits of these actions would only be achieved with voluntary compliance and an active educational outreach program. The most effective way to ensure compliance with no trawling on all coral is to updates maps with those small coral areas that appear to be outside of other protected areas, and to continue identification and mapping of potential new coral habitats in deeper waters (see Sections 3.1.1.3 and 3.2.2.2.1). For regulatory and enforcement considerations, as well as to make compliance by fishermen as easy as possible, it would be most appropriate to map a boundary around corals with a small buffer, and following straight latitude and longitude lines.

The Gulf Council and NOAA Fisheries could generically amend all FMPs together or the seven FMPs separately, if the Gulf Council and NOAA Fisheries choose Alternative 2. Administrative costs to the Gulf Council and NOAA Fisheries are reduced by about one-quarter through a Generic Amendment process, rather than amending each FMP individually. Examples of recent administrative costs for documents prepared by the Southeast Region of NOAA Fisheries and various U.S. fishery management councils are: Gulf of Mexico Council's Sustainable Fisheries Act Generic Amendment at $35,000 in Council costs and $22,000 in NOAA Fisheries costs, and the Dolphin/Wahoo FMP shared by 4 Councils at $248,000 in Council costs and $50,000 in NMFS costs. The Gulf Council and NOAA Fisheries would normally need approximately 1.5-2 years to amend the Generic Amendment, and longer to amend each of the FMPs. However, this document contains the analysis needed for preparing an amendment, which will reduce the time required to implement an Amendment. A court-ordered schedule requires amending the FMPs to comply with the EFH provisions of the M-S Act, if required, by December 26, 2005.

Practicability: In summary, enforcement of no trawling on coral should not require many changes to current activities; requiring aluminum doors would be conducted the same as TED or BRD inspections, but management and enforcement of the remaining three actions would be difficult.

4.3.7.3 Alternative 3

Alternative 3: Establish moderate modifications to fishing gears and a gear closure on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 2, apply the following action items:

- Limit use of tickler chains to one chain with a maximum ¼ inch link diameter
- Limit total trawl headrope length to 180 feet or less
- Limit trawl vessels to 85 feet or less in length overall (LOA), and grandfather existing vessels
- Prohibit trotlines when using traps/pots

Under this alternative the fishing restrictions include those of Alternative 2, as well as additional measures. For new actions, management measures dealing with trawling would apply only to the Shrimp FMP, and measures dealing with trotlines would apply to the Stone Crab and Spiny Lobster FMPs. The increased level of effort for Federal and state agencies would be moderate, most notably the increase for enforcement requirements of the restrictions.

Practicability: Like all management measures, each of these requirements requires a measure of voluntary compliance. The same enforcement issues of Alternative 2 would occur for Alternative 3. Additional measures for headrope length, vessel LOA, and limit of one tickler chain a maximum diameter could be largely monitored at port or during routine boardings at sea. The prohibition of trotlines will be more difficult (not as practicable) to monitor and would primarily require at-sea or monitoring from the air. Due to the trap reduction programs for lobster and crab, the number of traps permitted is well known. If visual sightings of buoyed traps are much less than what is permitted, it would suggest that more at-sea monitoring is required for compliance.

The Gulf Council and NOAA Fisheries could generically amend all FMPs together or the seven FMPs separately, if the Gulf Council and NOAA Fisheries choose Alternative 3. The costs would be similar to those described under Alternative 2.

4.3.7.4 Alternative 4

Alternative 4: Establish major modifications to fishing gears and gear closures on sensitive habitats to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. In addition to the restrictions listed in Alternative 3, apply the following action items:

- Limit total trawl headrope length to 120 feet or less
- Limit trawl vessels to 81 feet or less LOA on hard bottom or SAV
- Prohibit use of tickler chains on hard bottom
- Prohibit use of all traps/pots and bottom longlines and buoy gear on coral
- Prohibit all use of anchors on coral, and require use of mooring buoys if vessels need to "anchor" or maintain a stationary position

Under this alternative the fishing restrictions, and thus regulatory and enforcement responsibilities of NOAA Fisheries, are expanded beyond those of Alternative 3. Management measures dealing with trawling would apply only to the Shrimp FMP, measures dealing with traps/pots would apply to the Stone Crab and Spiny Lobster FMPs, measures dealing with bottom longlines and buoy gear would apply to the Reef Fish FMP, and measures dealing with anchors would apply to Reef Fish, Coastal Pelagics, Spiny Lobster, and Coral FMPs.

The same regulatory and enforcement impacts discussed under Alternative 3 would occur for Alternative 4. Enforcement for the additional restrictions for headrope and boat lengths would not change from that described under Alternative 3, and could largely be monitored at port.

The most effective way to ensure compliance with no traps/pots, bottom longlines, buoy gear, or anchoring on all coral is to update maps with those small coral areas that appear to be outside of other protected areas, and to continue identification and mapping of potential new coral habitats in deeper waters (see Sections 3.1.1.3 and 3.2.2.2.1). For regulatory and enforcement considerations, as well as to make compliance by fishermen as easy as possible, it would be most appropriate to map a boundary around unprotected corals with a small buffer, following straight latitude and longitude lines. This would allow enforcement of this area closed to these gears the same as any other closed area. It is not anticipated that this would involve more than one or two additional zones.

It would be very difficult for enforcement to monitor vessels of a certain size over a particular habitat, such as hard bottoms or SAV, unless this vessel size restriction was mandatory on all habitats. Likewise, limitations on anchoring on corals would require monitoring at sea or via air patrol.

The Gulf Council and NOAA Fisheries could generically amend all FMPs together or the seven FMPs separately, if the Gulf Council and NOAA Fisheries choose Alternative 4. The costs would be similar to those of Alternative 2.

In summary, this alternative would be somewhat more practicable to enforce, since it involves prohibition of several activities in a closed area. The impacts of other actions will be the same as in Alternative 2 and 3.

4.3.7.5 Alternative 5

Alternative 5: Prohibit gears and fishing activities that have adverse impacts on EFH from the EEZ. Apply the following action items:

- Prohibit use of all bottom trawling gear
- Prohibit use of all traps and pots
- Prohibit use of all bottom longline & buoy gear
- Prohibit use of all spears and powerheads
- Prohibit use of all vertical gear
- Prohibit use of all anchors

Under this alternative the fishing restrictions are the most severe and comprehensive of the alternatives. Relative to Alternatives 2, 3, 4, and 6, this Alternative would be easier to implement within each of the respective FMPs, but would be highly controversial, which is all a measure of practicability. Management measures would apply to Reef Fish, Coastal Migratory Pelagics, Shrimp, Stone Crab, Spiny Lobster, and Coral FMPs. The most notable increase in the level of effort for Federal and state agencies would be for enforcement requirements of the restrictions.

Under this Alternative, few gears would remain legal in the EEZ, thus enforcement activities would orient toward assuring that fishing with illegal gears does not occur. These actions are the least complicated, do not require special boundaries around particular habitats for particular gears, and thus should be easier to enforce than Alternatives 2, 3, 4, and 6.

The Gulf Council and NOAA Fisheries could generically amend all FMPs together or the seven FMPs separately, if the Gulf Council and NOAA Fisheries choose Alternative 5. The costs would be similar to those of Alternative 2.

Since this Alternative is likely to encourage fishing activity to move into unrestricted waters, there could be more regulatory and enforcement burden on each individual state marine fisheries agency.

4.3.7.6 Alternative 6 (Preferred alternative)

Alternative 6 (Preferred Alternative): Establish minor modifications to fishing gears and gear closures on sensitive habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ with the following action items:

- Regulate fishing weights on vertical line fishing gear used over coral reefs in HAPCs
- Prohibit bottom anchoring over coral reefs in HAPCs
- Prohibit use of bottom longlines, buoy gear, and all traps/pots on coral reefs
- Prohibit the use of trawling gear on coral reefs
- Require a weak link in the tickler chain of bottom trawls on all habitats

This Alternative selects from among all the management measures listed in Alternatives 2-5, to develop a suite of measures most likely to result in substantial benefits to EFH while not causing undue economic or social burdens on fishers; it is considered the most practicable. This alternative would have intermediate influence on regulatory requirements. Alternative 6 would cause some additional administrative requirements above those of Alternatives 2-5; the regulation of weight restrictions for vertical gear used over coral will require additional assessment and analysis and due to the large number of recreational fishermen on the water, an extensive education and outreach effort would be required to ensure voluntary compliance with such regulations. The resulting measures would apply to the Reef Fish and Coastal Migratory Pelagics FMPs. Measures dealing with prohibition of anchoring would apply to the Reef Fish, Coastal Migratory Pelagics, Spiny Lobster, and Coral FMPs. Measures dealing with prohibition of bottom longlines and buoy gear would apply to the Reef Fish and Coral FMPs. Measures dealing with prohibition of traps/pots would apply to Reef Fish, Spiny Lobster, Stone Crab, and Coral FMPs. Measures dealing with prohibition of trawling would apply to the Shrimp and Coral FMPs. Measures dealing with tickler chains would apply to the Shrimp FMP. The requirement for a weak link in trawl tickler chains will also need further assessment and analysis (e.g. an IRFA).

Increased enforcement activity would be required beyond status quo (Alternative 1) to assure compliance with all measures. Use of legal gears in a partially closed area might increase the difficulty of enforcing prohibitions of other gears. As always, there might be the anticipation of a certain amount of illegal fishing activity, however, on the water enforcement or patrols should reduce this. This will be feasible since coral reef areas are already primarily in protected areas, as are the preferred HAPCs.

As described under Alternative 2, the most effective way to ensure compliance with fishing restrictions on all coral is to update maps with those small coral areas that appear to be outside of other protected areas, and to continue identification and mapping of potential new coral habitats in deeper waters (see Sections 3.1.1.3 and 3.2.2.2.1). For regulatory and enforcement considerations, as well as to make compliance by fishermen as easy as possible, it would be most appropriate to map a boundary around corals with a small buffer, and following straight latitude and longitude lines.

The Gulf Council and NOAA Fisheries could generically amend all FMPs together or the seven FMPs separately, if the Gulf Council and NOAA Fisheries choose Alternative 6. These administrative costs would be similar to those of Alternative 2.

4.3.7.7 Alternative 7

Alternative 7: Establish some minor modifications to fishing gears and one major gear closure on sensitive live hard bottom habitat to prevent, mitigate, or minimize adverse fishing impacts in the EEZ. The actions include:

- Limit bottom longline sets to 5 miles in length, and to 3 sets/day
- Prohibit trotlines when using traps/pots
- Prohibit all anchoring
- Enact a seasonal closure for shrimp trawl fishing

Management measures dealing with bottom longlines would apply only to the Reef Fish FMP; measures dealing with trotlines would apply to the Spiny Lobster, Stone Crab, and Reef Fish FMPs; measures dealing with anchoring would apply to the Reef Fish, Coastal Migratory, Spiny Lobster, and Coral FMPs, and measures dealing with shrimp trawling would apply to the Shrimp FMP.

Enforcement requirements would increase, and some measures of Alternative 7 are difficult to enforce (e.g. length and number of longline sets). It might be possible to measure longline lengths during a boarding inspection, however, it would not prevent fishermen from potentially stringing more than one line together while actively fishing. This type of gear restriction is best when paired with requiring the use of vessel management systems (VMS). When calibrated properly, VMS systems can measure active fishing effort through monitors on engines, winches, and distance traveled. Limitations on anchoring associated with fishing activities would require monitoring at sea or via air patrol, and could be more readily monitored if mooring buoys were also established.

The prohibition of trotlines will be more difficult (not as practicable) to monitor and would primarily require at-sea or monitoring from the air. Due to the trap reduction programs for lobster and crab, the number of traps permitted is well known. If visual sightings of buoyed traps are much less than what is permitted, it would suggest that more at-sea monitoring is required for compliance with this action.

The most effective way to ensure compliance with seasonal shrimp trawling closures on all live hard bottom is to update maps with those hard bottoms that appear to be outside of other protected areas, and to continue identification and mapping of potential new hard bottom habitats in deeper waters. For regulatory and enforcement considerations, as well as to make compliance by fishermen as easy as possible, it would be most appropriate to map a boundary around these live hard bottom areas with a small buffer, and following straight latitude and longitude lines. Considering that most of the live hard bottom area is in one large zone of the central and southwest coast of Florida, this alternative would be the most practical to enforce. It would be similar to other seasonal closures for shrimping already in force (i.e. Texas Shrimp Closure). It could be even more reliably enforced if VMS systems were required for all shrimp vessels operating in Federal waters.

The Gulf Council and NOAA Fisheries could generically amend all FMPs together or the seven FMPs separately, if the Gulf Council and NOAA Fisheries choose to implement Alternative 7. The costs would be similar to those described under Alternative 2.

Practicability: In summary, enforcement of no trawling on live hard bottom should not require many changes to current activities; enforcement to restrict longline lengths and prohibit anchoring associated with fishing could be conducted in the same fashion as TED or BRD inspections.

4.3.8 Cumulative impacts

Cumulative impacts are impacts on the environment that result from the incremental impact of an action (alternative) when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time. In general, the cumulative impact of the proposed alternatives are likely to be adverse in the short term for the human and administrative environments, but may provide long-term, beneficial, cumulative effects on the physical, biological, and human environments in the Gulf of Mexico. The beneficial cumulative impact for fisheries habitat from the proposed actions, however, is minor, particularly in the estuarine and nearshore environments, when compared to reasonably foreseeable impacts from a variety of non-fishing activities such as shipping, dredging, oil and gas exploration and coastal development (Figure 4.3.2). Increases in one or several of the non-fishing effect activities could have significant effects on EFH in the Gulf of Mexico. Some effects, such as dredging and filling, could have greater impacts than fishing gear effects since a complete loss of habitat may occur within a given area rather than some degree of degradation. Although difficult to quantify, future population growth and development is likely to result in further losses of EFH due to increases in dredging and filling, point and non-point source pollution, and associated nutrient loading and eutrophication effects. If oil and gas operations along the Florida coastline were ever approved, risks to sensitive nearshore and estuarine habitats would increase (MMS 2002a). None of the proposed alternatives to restrict fishing effects would curb significantly the cumulative effects of these foreseeable impacts.

The following sections review the practicability of the proposed alternatives, then consider the potential cumulative impacts for the physical, biological, human and administrative environments.

4.3.8.1 Practicability of the alternatives to address fishing impacts

A summary of each practicability factor for each alternative to address fishing impacts is provided in the following table. It is very difficult to make direct quantitative comparisons and provide specific quantified answers to questions of practicability, due in part to uncertainty in the direct effects of fishing gears on habitat functions and the lack of information on the relationships between habitat function and the productivity of managed species (see Section 2.1.3). However, a qualitative analysis was conducted based on the best available science.

Modifying, restricting, or prohibiting the use of fishing gear or particular fishing activities will result in some incremental positive change to the environment from the status quo. Benefits are primarily biological, leading to environmental conditions that better support sustainability of EFH and managed species. These incremental environmental benefits are detailed in Sections 4.3.2 through 4.3.5. In general, if previously impacted fish productivity recovers, then higher catches in the future may lead to secondary economic benefits for the human environment in the long-term. However, the economic benefits for fishers that might arise from this are likely to be dissipated in an open access environment (e.g. Freeman 1993, see also Section 2.1.6.2.2.1). In addition, continuing adverse impacts on habitat from non-fishing activities such as coastal development and pollution (Sections 3.5.2, and 4.3.8.2-4.3.8.6) may limit the scope of improvements in productivity that can be achieved by modifying fishing activity alone. The corollary of this is that in addition to direct biological costs of not taking action, there may be secondary, future economic costs for the human environment, arising from declines in productivity. The primary, direct, short-term consequences of the alternatives for the human and administrative environments will be in the form of economic costs that of modifying fishing gear, relocating fishing effort, reduced catches, implementation of regulations, and increased surveillance and enforcement.

Both Alternative 1 (status quo) and Alternative 5 (the complete ban on the use of gear or fishing activities with adverse impacts in the EEZ) are not practicable because they do not find a balance between what is "reasonable and capable of being done [to protect EFH and support its functions for managed species] in light of available technology and economic considerations." Alternatives 2, 3, 4, 6 and 7 each lie between the extremes represented by Alternatives 1 and 5. Several actions in Alternative 2, have been found to be very difficult to enforce for minimal environmental benefit, thus it was not considered practicable. The combination of actions in Alternatives 3, 4 and 7 potentially provide incrementally more benefits to EFH and fish abundances, however several specific actions could introduce greater threats to large whales. The threats to these protected species, in addition to enforcement difficulties and potential costs to fishermen do not outweigh the potential, somewhat speculative environmental improvements to EFH, thus these are also not considered the most practical.

However, several actions contained in Alternatives 2 and 4 were considered by the Gulf Council to be very important for coral habitats (EFH and in HAPC) that are particularly sensitive to impacts from a variety of gear. The Council paired these specific actions with one new action (use of a weak link with tickler chain), after review of the potential environmental benefits to EFH and social and economic costs to form Alternative 6. The Gulf Council considers Alternative 6 to provide the best balance: it is reasonable and capable of being done light of available technology and does not result in economic hardship on any particular fishery or fishing community.

Practicability Factor	Description	Summary of Practicability factor for each alternatives to prevent mitigate, or minimize adverse fishing impacts in the EEZ						
		1	2	3	4	5	6	7
Changes in EFH	**Future improvement or degradation in the extent, quality and/or function of EFH resulting from fishing impacts alternatives**	Ongoing trends in damage to marine habitats would continue	Some environmental benefits to coral reefs, hard bottoms and SAV	Some environmental benefits to coral reefs, hard bottoms, SAV, sand and soft bottoms.	Most positive environmental benefits to coral reefs, and some benefits to hard bottoms, SAV, sand and soft bottoms.	Maximum protection possible; would allow adversely impacted bottom habitats to recover from past fishing impacts, barring impacts from other external factors	Positive environmental benefits to coral reefs, and some benefits to hard bottoms, SAV, sand and soft bottoms	Most positive environmental benefits to live hard bottom, but potentially negative benefits to sand and soft bottoms if fishing effort is displaced there.
Population effects on FMU species from changes in EFH	**Magnitude and direction of productivity changes resulting from changes in EFH**	Over time, habitat damage is expected to lead to some reductions in abundance for managed species, and that decline would continue	Minor changes in fish abundance if habitats that have been degraded are allowed to recover and provide improved carrying capacity for managed species	Incrementally more benefits to fish abundance for managed species than Alt. 2	Incrementally more benefits to fish abundance for managed species than Alt. 3	Substantially more benefits to all fish abundances if degraded habitats are allowed to recover and if fishing mortality approaches zero	Minor changes in fish abundance if degraded habitats are allowed to recover; Benefits lie between Alts. 2 & 4	Minor changes in fish abundance approximately equivalent to Alt. 3.
Ecosystem changes from changes in EFH	**Improvement or degradation of ecosystem function resulting from changes in EFH**	Some reductions in non-managed species; status quo impact on protected species	Some, minimal improvement to the ecosystem, compared with the status quo (Alt. 1)	Some, minimal benefit to ecosystem and sea turtles, but potential to introduce a greater threat to large whales compared with the status quo	Some, minimal benefit to ecosystem and sea turtles, but potential to introduce a greater threat to large whales compared with the status quo	Positive benefits to ecosystem & all protected species the offshore; some negative impacts to dolphins & sea turtles in estuarine & coastal regions. Overall, positive impacts outweigh negative impacts.	Limited positive benefits to sea turtles, in offshore environment; no impact, positive or negative, on other protected species	Some, minimal benefit to ecosystem and sea turtles, but potential to introduce a greater threat to large whales compared with the status quo
Net economic change to fishers	**Changes in short-term and long-term economic conditions of individual fishermen as a result of fishing impacts alternatives**	Short term economic cost = zero. In the long term, continued habitat degradation, to the extent that this is occurring	Benefits of some of the specific actions may exceed costs, though the level of uncertainty is substantial	Detailed economic analysis of the costs & benefits is required; need estimates of relative change in costs to changes in fishing practices; information is not	Costs and benefits should exceed Alt 3, however can reach no conclusions regarding the total benefits and costs	Extreme net economic costs to fishermen	Should provide economic benefits to the nation. However, requires a more definitive analysis to determine if	Potential costs appear to be nearly equivalent or with costs slightly outweighing benefits; more detailed

Practicability Factor	Description	Summary of Practicability factor for each alternatives to prevent mitigate, or minimize adverse fishing impacts in the EEZ						
		1	2	3	4	5	6	7
				available now; costs to collect/ estimate would be exorbitant			actual benefits exceed costs	economic analysis required.
Equity of potential costs among communities	**Equity around the regi on, in relation to short-term and long-term economic conditions of fishing communities as a result of fishing impacts alternatives**	Potential net negative impacts to habitats and the fisheries; it is not possible to predict if one community would be impacted more than another	Difficult to fully measure social impacts; vary depending upon the vessel's location and mobility (requiring aluminum doors would affect all shrimpers located around the Gulf; longline restrictions will have a greater impact on reef fish fishermen in Florida than other states).	Some communities will be more vulnerable than others; For the prohibition on trotlines, those communities most affected would be those listed under the lobster permit table (Key West, Miami, Marathon, Appendix table G.1.10)	In addition to impacts of Alts 2 & 3, communities most likely to be affected include Marathon, Key West, Naples, Madeira Beach, Tarpon Springs, Panama City, FL; Port Aransas, Galveston & Freeport, TX: locations from which charters & commercial fishermen head to the Flower Gardens, Tortugas or FL Middle Grounds (Appendix Table. G.1.5, G.5.5).	Significant impacts across the commercial and recreational fishing fleet; social impacts would be significant as owners, captains and crew would likely have to seek alternative employment; vital support industries that supply vessels with gear, fuel, repairs and groceries would also be impacted.	Impacts lie between Alt 2 & 4; communities with *both* reef fish vessels and shrimp vessels are potentially more vulnerable under this action. However, since coral habitat in the entire Gulf is very small and most are already closed to many gears, it is unlikely that any community will be unduly impacted.	Communities most likely to be affected include those on the west coast of Florida from Cedar Key to Key West.
Effects on enforcement, management, & admin.	**Changes in requirements or effectiveness of enforcement, management, and administration as a result of fishing impacts alternatives**	Would require no amendments to the Gulf of Mexico FMPs, and no changes to the current regulatory process	Enforcement of no trawling on coral should not require many changes to current activities; requiring aluminum doors would be conducted the same as TED or BRD inspections, but management and enforcement of the remaining	Requires a measure of voluntary compliance; same enforcement issues as Alt. 2; certain actions can be handled during routine boardings; prohibition of trotlines will be difficult to monitor	Would be somewhat more practicable to enforce, since it involves prohibition of several activities in an existing closed area. The impacts of other actions will be the same as in Alts. 2 and 3.	Combined actions are the least complicated, do not require special boundaries around particular habitats for particular gears, and thus should be easier to enforce than Alternatives 2, 3, 4, and 6.	Increased enforcement would be required beyond status quo; use of legal gears in a partially closed area might increase enforcement difficulties. Feasible since coral reef areas are already in protected areas,	Requires a measure of voluntary compliance, particularly for longline fishermen and general anchoring activities. Would be somewhat more practicable to enforce the seasonal shrimp

Practicability Factor	Description	Summary of Practicability factor for each alternatives to prevent mitigate, or minimize adverse fishing impacts in the EEZ						
		1	2	3	4	5	6	7
			three actions would be difficult.				as are the preferred HAPCs.	closure, since enforcement agencies already manage this type of action.

4.3.8.2 Physical Environment

The majority of impacts to the physical environment are a result of historic past actions (geologic formations, sea floor movements), storm events, and recent actions related to shipping, the oil and gas industry, and upland development. For example, the coastal wetlands of Louisiana are being lost due to subsidence and loss of depositional accretion from historic freshwater flow patterns that are now altered by water diversion structures.

Figure 4.3.2 compares the impacts of individual fishing activities to non-fishing activities (impacts from maritime-related activities, terrestrial development, and marine development) on a relative scale of low, medium, and high. The combined impacts of non-fishing activities is greater than the fishing activities, particularly for estuarine and nearshore habitats. However, offshore, particularly in the western Gulf, the past impacts from oil and gas activities are considerable. Figures 3.2.8 and 3.2.9 show the distribution of oil and gas structures and pipelines, respectively. There are an estimated 4,000 platforms in the Gulf (MMS 2000). Foreseeable events anticipated to continue include expansion of outer continental shelf activities.

Other activities expected to continue into the future along the coast and offshore include: navigation dredging, new channels, ports expansion, pipelines, marinas, wetland filling and many others. The ongoing impacts of these actions and other future similar actions will lead to incremental increases in degradation and loss of biogenic structure and hard bottom habitat important to fisheries. Many changes to the physical environment due to a variety of fishing and non-fishing activities, e.g. loss of geologic formations, clay banks, coral reefs, may be considered permanent for all intents and purposes as the time frames required to reform them are on the order of hundreds or thousands of years.

While less severe in nature than the above activities, the adverse cumulative effects of current fishing activities on the physical environment, including anchoring, trawls and doors, bottom long lines, traps, and propeller scarring on hard bottom fisheries habitat would continue to accrue under Alternative 1. Progressively greater protections under Alternatives 2 through 5, including Alternative 7, would be expected to slow the cumulative impacts of degradation and loss of hard bottom fisheries habitat due to fishing impacts. The prohibitions of gears and fishing activities that adversely affect EFH under Alternative 5 would have the greatest positive impact on hard bottom fisheries habitat in the Gulf of Mexico.

4.3.8.3 Biological Environment

The majority of impacts to fisheries are associated with past actions (over-fishing, disturbance, physical damage to and loss of habitat). Actions to control fishing activity are foreseeable as part of ongoing fishery management activities. The cumulative effects of alternatives to reduce fishing impacts on EFH, when added to other foreseeable actions controlling fishing, will vary under the respective alternatives. Under Alternative 1, current commercial and recreational fishing activities would continue. As a result, degradation of existing conditions and subsequent loss of fisheries habitat associated with these activities would continue to accrue. Additional protections provided under Alternatives 2, 3, 4, 6 and 7 and full fishing gear prohibitions under Alternative 5 would be expected to progressively increase the long-term benefits to the biological habitat, primarily as a result of decreased damage to physical habitat and direct loss of living components such as sea grasses (SAV), small patches of coral, sponges and gorgonians.

The estuarine and nearshore environment is greatly influenced by development, loss of freshwater flow, non-point source (agricultural uses, urbanization that affects runoff) and point source pollution. Altered freshwater inflows affect the salinity zone in estuarine and nearshore areas and can directly affect the distribution of seagrasses, reef systems, and other habitat types. Other activities such as impoundment, coastal development, water diversions, thermal additions, actions that contribute to sedimentation, introduction of potentially hazardous materials, introduction of exotic species, vessel use, and the conversion of aquatic habitat may eliminate, diminish, or disrupt the functions of EFH. Most of these activities can moderately to severely directly disturb sensitive biological habitats, and the water quality and quantity of the affected area. Habitats at highest risk include coral reefs, seagrasses, mangroves, oyster bars, marshes and benthic algae, primarily due to the fact that these habitats are comprised of living organisms susceptible to chemical and physical impacts. Areas of highest risk to non-fishing impacts were predicted for the Florida Keys where extensive coral reef and seagrass habitats are present, the northwestern coastline of Florida where extensive seagrass beds are present, and coastal Louisiana where extensive marsh habitats exist (Figures 3.5.29a, b). Smaller, but high risk areas also were mapped for seagrass, marsh, mangrove, and oyster bar habitats within Florida and Texas coastal estuaries.

EPA reports (1999) that 35 percent of estuarine areas identified as impaired were degraded by pathogens (fecal coliform) and eutrophication (nutrients, organic enrichment, low DO). Major activities affecting Gulf coastal water quality include those associated with the petrochemical industry; hazardous and oil-field wastes disposal sites; agricultural and livestock farming; power plants; pulp and paper plants; fish processing; commercial and recreational fisheries; municipal waste water treatment; mosquito control activities; maritime shipping; and land modifications for flood control and river development, and for harbors, docks, navigation channels, and pipelines.

Fishing activities also occur in the nearshore environment, but would not be directly affected by the proposed alternatives because they are regulated by state, not Federal, fishery managers. However, this EIS makes conservation recommendations to state fishery managers (Section 4.5.1.2) with respect to estuarine and nearshore impacts from adverse fishing activities. It is anticipated that at least some of these recommendations will occur in the future, and provide cumulative benefits to these habitats.

Increases in one or several of the non-fishing activities could have significant effects on EFH in the Gulf of Mexico. Some effects, such as dredging and filling, could have greater impacts than fishing gear since a complete loss of habitat occurs rather than incidental damage. Although difficult to quantify, future population growth and development is likely to result in further losses of EFH due to increases in dredging and filling, point and non-point source pollution, and associated nutrient loading and eutrophication effects. If oil and gas operations along the Florida coastline were ever approved, risks to sensitive nearshore and estuarine habitats would increase (MMS 2002a).

Based on analyses described in Chapter 3, dredge and fill activities appear to have the greatest potential effect on fisheries habitats. This is due to the fact that dredging and filling involve physical disturbances that can result in the conversion of a highly productive and structurally complex habitat (e.g., seagrass) to a less productive bare sand habitat (e.g. during dredging of a channel) or the conversion of an aquatic habitat to an upland land mass. Other activities with potentially significant effects appear to be oil and gas operations/industrial spills and altered freshwater inflows. Oil and gas operations have the potential to result in oil and oil drilling related chemical spills and can have an acute toxic effect on living habitats (seagrasses, coral reefs) and also contaminate the pelagic zone making it uninhabitable by aquatic organisms (Williges *et al*. 1998; Preston and Shackelford 2002). These activities also include disturbance to habitats by pipeline and oil platform construction.

The benefits of mitigating fishing impacts will be greatest in those regions of the Gulf where non-fishing impacts are lowest. Non-fishing effects vary throughout the Gulf of Mexico, depending on the amount of offshore oil production and the extent of coastal development, and appear to be correlated with development and population density. Thus, the incremental benefit of the gear prohibitions would be greater along parts of the Florida and mid-Texas coastlines where non-fishing impacts are relatively low compared to Louisiana where the nearshore effects of coastal development outweigh fishing effects on EFH.

4.3.8.4 Human Environment

Unlike the physical and biological environments, short-term, adverse, cumulative impacts to the fishermen and fishing communities are anticipated under Alternatives 2 – 6, and are expected to be greatest under Alternative 5 (prohibition of gears and activities that adversely impact EFH). These impacts are expected primarily as a result of costs associated with changes in fishing activities, restrictions in fishing, competition with farm-raised and foreign imports of fish, and subsequent greater expenses associated with commercial fishing, as described in previous sections. While immediate adverse economic impacts are not anticipated under Alternative 1 (status quo), long-term cumulative impacts are expected as a result of adverse impacts to fisheries habitats and subsequent long-term reductions in abundances of fish.

Cumulative impacts of the greater cost to fishermen associated with changing gears and practices, combined with nearshore impacts of non-fishing activities, such as dredging and non-point source pollution, can be expected to exacerbate any adverse economic impacts to fisherman, particularly if Alternatives 2, 3, 4, 5 or 7 were pursued as preferred. However, based on the analyses and information presented in Section 4.3, actions to prevent, mitigate, or minimize fishing impacts to fisheries habitat is expected to have a long term beneficial effect on fisheries and therefore the fishing industry. In particular, Alternative 6 prevents the most severe of potential impacts, while not unduly burdening fishermen.

Detrimental effects of any restrictions on fishing activities would be expected to be relatively short term, with losses more than balanced by long term gains in fish abundances. Evidence from boreal, temperate, and tropical regions of the world support the theory that if habitat degradation is halted or minimized, and biological integrity is restored, associated fish populations will increase both inside and outside the restored areas. This prediction is supported by more than 250 peer-reviewed articles on recovery dynamics of marine fishery reserves in studies around the world (NMFS 1997).

The Council intends to rationalize fishing effort in the reef fish, for hire, and commercial shrimp fisheries through future regulatory actions (Amendment 18, Reef Fish FMP; Amendment 14, Shrimp FMP) (Council motion, May 2003). The actions of the Preferred Alternative 6, predominantly affects these two fisheries. Rationalizing these fisheries is anticipated to reduce fishing effort, thereby reducing the use of fishing gears that have had adverse impacts on habitat, and resulting in beneficial effects to EFH. This is anticipated to cumulatively provide increased benefits to EFH in conjunction with the Preferred Alternative 6.

4.3.8.5 Administrative Environment

The cumulative impacts of any of these Alternatives will primarily be associated the regulatory actions associated with modifying Federal fishing activities which would be expected to increase if the Preferred Alternative (Alternative 6) or Alternatives 2-5 and 7 are implemented. There would be little change or impact anticipated with respect to the consultation process for either NOAA Fisheries or other Federal agencies as a result of potential minor changes in the designation of EFH in conjunction with modifications to Federal fishing activities. The potential incremental increase in the level of scrutiny that activities may receive if proposed in areas identified as HAPC or adjacent to HAPC will not greatly impact these Alternatives, although the Council's Preferred HAPC Alternative did influence the actions in the Preferred Alternative to prevent, mitigate, or minimize the adverse affects of fishing on EFH.

Alternatives 2 – 5 specify more types of habitat within which fishing activities require changes or modifications, thus these alternatives would have greater impact on the regulatory process and for future enforcement activities than the Preferred Alternative 6, which only identifies fishing activities on coral or coral in HAPCs, or Alternative 7, which only limits activities on live hard bottom.

Enforcement of any new regulations that result from the Preferred Alternative would place an additional burden on the U.S. Coast Guard and NOAA Office of Enforcement. Many of the enforcement activities required for effective compliance of the fishing impacts alternatives must occur at sea, and measures that enhance at-sea enforcement capabilities will improve compliance. Several of the actions in the Preferred Alternative invoke an area restriction around coral reef or for coral in HAPCs. Because marine management areas (MMA) cannot be fenced off like their counterparts on land, completely effective law enforcement would require the presence of a law enforcement vessel at MMAs to document any infraction of the rules. Such a presence is time consuming, very costly, and unlikely to occur permanently given the many other obligations of law enforcement agencies. Additionally, the manner in which some regulations are written, officials often cannot take action on an infraction unless they themselves witness and document the occurrence.

Fisheries regulations that are unenforceable can create considerable frustration on the part of the fishermen, the public and law enforcement officials. Therefore, alternative solutions to these enforcement issues are sought in order to ensure effective enforcement.

Monitoring fishing activity involves three components: the location of the vessel, the activity of the vessel at each location, and whether the activity is in compliance with regulations. Description of activities could consist of several broad categories: transiting but not on the fishing grounds; on the fishing grounds but not fishing; actual fishing operations; and unloading product. More detailed information on vessel activity can also be collected using monitors attached to key components of the vessel's equipment, such as trawl winches, longline haulers etc. Technology exists to electronically track these major categories of activities through use of vessel monitoring systems (VMS) with GPS locators, video cameras, hydraulic sensors, and computer software.

Of these technologies, VMS is the most common. VMS devices are placed on the vessel and can vary a great deal in their cost depending upon the type of system that is used. Some of the more expensive systems use satellite technology and offer many other services to both law enforcement and fishermen. Other less expensive systems may use cell phone technology and have limited service capabilities. In either case, the costs are often placed on the owner of the vessel. Those costs may seem a burden if the benefits of such a service are viewed as unnecessary or have little utility to the fishing operation. The costs of such a system may be viewed as less of a burden if they offer fishermen some advantage or provide for increased safety. In addition, there are administrative costs associated with these systems as data are constantly reported and must be monitored.

Vessel monitoring systems can be viewed as intrusive by those whose activity is being monitored. Fishermen especially, show resistance prior to the introduction of such technology that stems from their desire to protect important fishing locations and their fear that others may gain access once data are being transmitted through these types of systems. It is important that when implementing such a system that safeguards are in place to ensure confidentiality. Experience from elsewhere shows that following its introduction, VMS tends to be accepted by the fishing community and viewed by fleet managers as a useful management tool, with a variety of added benefits, including safety.

The Gulf Council intends to incorporate the use of VMS in future regulatory actions, particularly related to both the Shrimp and Reef Fish FMPs (Council motion, May 2003). The actions of the Preferred Alternative 6, predominantly affects these two fisheries. Enforcement efforts of the proposed fishing restrictions on coral and on coral in HAPCs will be greatly enhanced by a VMS requirement in the future.

4.4 Research recommendations

4.4.1 Summary of recommendations

This section provides research and conservation recommendations with two main objectives:

- improving the understanding of the relationships between species productivity and habitat structure and function; and
- improving the quality of data on fishing impacts

The first of these objectives will improve the availability of information for describing and identifying EFH at levels 3 and 4 (see Section 2.1.3.2). This will enable more refined and precise identification of EFH and HAPCs. It will also allow better understanding of the ways in which fishing and non-fishing impacts affect the function of habitat and change the way in which habitat supports the productivity of managed species. This will enable more effective and better-informed development of management actions for the prevention, minimization or mitigation of threats to EFH. Recommendations regarding scientific and research needs are provided in Section 4.4.1, including overview of on-going work to obtain and improve fishery information.

One of the main requirements to meet the second objective is better data on fishing effort. As described in Section 2.1.5.2.1, to determine the impacts to habitat from fishing, it is necessary to have fishing effort data broken down by location on as fine a scale as possible, preferably haul-by-haul, including start and end points for deployed gears. Haul-by-haul data would allow detailed analyses of the proportion of each habitat type actually impacted, and the proportion and frequency of repeat impacts on the same patch of habitat compared to the proportion of impacts on virgin habitat. Effort data for the Gulf of Mexico are available only in an aggregated form, on a trip-by-trip basis. Multiple trips are assigned to a statistical area on a map – for example one of the 21 NOAA Fisheries statistical grid units (Figure 2.1.3), or depth sub-divisions within that grid in the case of shrimp trawls. Haul-by-haul data are not available, and therefore the analysis of fishing impacts is restricted to a relatively low level of precision.

The introduction of recording effort data on a haul-by-haul basis, through the use of logbooks (paper or, better still, electronic) would be a major step forward in the analysis of fishing impacts on habitat. One source of fine scale fishing effort data that would make an enormous impact on the possible scope of the analysis is automated vessel monitoring systems (VMS). These systems can record information on vessel position, speed, heading and a variety of other important parameters that characterize the activity of fishing vessels. While vessel position does not precisely tally with location of fishing gear, data from VMS would go a long way towards enabling a more realistic and accurate portrayal of the interaction between fishing gears and fish habitat.

4.4.2 On-going research programs

In the context of this EIS, the chief concern is how changes to habitat caused by human activities affect fish productivity. Research is needed to provide knowledge of the ecological processes that affect energy flow leading to fish productivity and responses of living marine resources to habitat and environmental changes. This understanding of ecological processes must then be linked with information on the health, distribution, and abundance of ecologically important organisms. By understanding the ecological linkages to the production of fishery stocks, managers of fisheries and habitat will be better able to manage living marine resources and their

Essential Fish Habitat (EFH). The remainder of this section describes on-going work to obtain and improve fishery information

Several institutional programs exist for obtaining fishery data filling in data gaps. These include:

- RecFIN and ComFIN programs (the Fishery Information Network) to collect Gulf-wide recreational and commercial fishery data;
- Annual Gulf of Mexico Operations Plan, through which the Gulf Council and NOAA Fisheries set priorities and a research program to reach them;
- Periodic reviews of stock assessment procedures, which recently resulted in a Stock Assessment Improvement Plan; and
- Implementation of the NOAA Fisheries Habitat Research Plan developed in 1996.

4.4.2.1 Fishery Information Network

NOAA Fisheries has collected commercial data since the 1950s, recreational harvest data since 1979, and initiated dockside interviews for commercial harvest in 1984. Efforts by state and Federal agencies, including the Gulf Council, to develop a cooperative data collection and management program began in the latter 1980s (FIN, 1996). The participating agencies recognized a requirement for statistically sound, timely, long-term, and comprehensive data. In the early 1990s, participants developed the Commercial Fisheries Information Network (ComFIN) and the Southeast Recreational Fisheries Network (RecFIN(SE)), which later evolved into the Fisheries Information Network (FIN). In 2002, for example, the FIN activities included:

- continued support for on-going commercial and recreational data collection,
- development of a commercial trip ticket for Texas, Mississippi, and Alabama; and combination of these data with other commercial data from the GOM;
- development of discards, releases, and protected species interactions modules;
- development of a social/economic module;
- development of a metadata database;
- collection of otoliths from recreational and commercial fisheries
- implementation of the FIN data management system

4.4.2.2 Gulf of Mexico Operations Plan

The Gulf Council and NOAA Fisheries annually set research priorities and an associated research program in the Gulf of Mexico Operations Plan. The 2003 version of this document comprises 13 pages of research objectives, some of which include habitat-related projects. Of note for 2003 are:

- a study to examine the habitat requirements of young vermilion snapper to evaluate if shrimp trawl bycatch can be expected to index recruitment accurately
- Mapping of EFH for reef fish in the Gulf of Mexico.

- Identification of EFH for reef fish: priority conservation areas for potential snapper/grouper fishery reserves in the eastern Gulf of Mexico
- Investigation of the importance of sea grasses as EFH in the Gulf of Mexico through studies which evaluate growth and production of fishery organisms.
- Investigation of the extent and function of offshore seagrass beds of the eastern Gulf of Mexico as an overlooked EFH.
- Characterization and quantification of EFH for juvenile Goliath grouper.
- Assessing the value of different coastal wetlands as nurseries for nekton.
- Assessing fishing gear impacts to EFH
- Determination of the rates and amounts of EFH losses to natural forces and man-induced perturbations.
- Development of design specifications for restoring functional habitats and enhancing rates of biotic increase and stability of restored habitats.
- Development of restoration techniques, siting criteria, and establishment guidelines for EFH in the Gulf of Mexico including seagrass, marshes, and hard bottoms.

In addition, the SEFSC in Miami and Galveston are working on a Pilot Program to improve NOAA Fisheries' capabilities for identifying, accessing, and using habitat data in the Gulf of Mexico.

4.4.2.3 Stock Assessment Improvement Plan

A number of species that are included in fishery management units of fishery management plans have never had a stock assessment conducted, although some data may have been collected and some simple time series plots or tabulations may have been created. Due to this large number of species for which assessments are sparse or lacking, NOAA Fisheries convened a National Task Force for Improving Fish Stock Assessments as part of its Science Quality Assurance Program. It was also tasked with addressing recommendations made in the National Research Council study on Improving Fish Stock Assessments (NRC 1998). The effort culminated in the report The Stock Assessment Improvement Plan (Mace, *et al.* 2001).

The report argues for greatly increased resources in terms of data collection facilities and staff to collect, process, and analyze the data, and to communicate the results, in order for NOAA Fisheries to fulfill its mandate to conserve and manage marine resources. In attempting to describe the data collection and assessment needs, Mace *et al*. (2001) were pragmatic. They agreed that the greatest impediment to producing accurate, precise, and credible stock assessments was the lack of the quantity, quality, and type of input data needed. However, even though there are relatively few stocks with comprehensive input data, a total of 119 stocks are routinely assessed using state-of-the-art age or size structured models, some of which may also incorporate spatial and oceanographic effects (Mace *et al*. 2001).

Overall, the two most important needs for obtaining adequate data are research vessel surveys designed to produce fishery-independent indices of abundance and to collect related information on spatial and temporal distributions, associated species, habitat, and oceanographic variables; and observer programs that provide information on species composition, amounts of each species kept and discarded, and fishing effort. They argued for the development of more partnerships and cooperative research with other Federal agencies, state agencies, private foundations, universities, commercial and recreational fishing organizations and individuals, environmental groups, and others with a vested interest in collecting similar types of data, although often for other purposes. They also encouraged NOAA Fisheries to "free up more time" for existing quantitative staff to pursue research that would lead to the development of new models and methodologies for conducting stock assessments, performing risk analyses and stock projections, and constructing multispecies and ecosystem models (Mace *et al*. 2001).

4.4.2.4 NMFS Habitat Research Plan

A NMFS Habitat Research Plan (Thayer et al.1996) identified the research needed to provide information necessary to protect, conserve and restore aquatic habitats. The Habitat Research Plan systematically guides habitat research in four areas: ecosystem structure and function, effects of alterations, development of restoration methods, and development of indicators of impact and recovery. Additionally, the plan emphasizes a fifth area -- the need for synthesis and timely information dissemination to managers.

Many of the data gaps identified in this EIS are also identified as research needs in this Research Plan. For example, to be able to predict organism and habitat response to perturbation, as well as for predicting recovery or restoration success, research is need on:

- the structure and function of natural ecosystems, their linkages, both internal and external, and the role they play in supporting and sustaining living marine resources (e.g., their distribution, abundance and health);
- the relationships between habitat and yield of living marine resources, including seasonal and annual variability and the influence of chemical and physical changes on these relationships; and
- cause-and-effect studies designed to evaluate responses of fishery resources and habitats to physical and chemical modifications due to natural and man-made alterations in coastal and estuarine systems.

Another need is for managers to be able to identify habitat status or "health." Research is needed to develop indicators to judge the status of an ecosystem, habitat or living marine resource and the need for corrective action. Studies should include:

- time-dependent population analyses and contaminant-level follow-up evaluations for sediment, biota, and water;
- standardization of indicators for specific habitats through comparisons across geographic gradients and scales; and
- assessment of the temporal efficacy of chemical "cleanup" techniques and most appropriate measures to assess success.

With regard to habitat restoration, methods should be designed to improve the current techniques used to clean up, restore, or create productive habitats, as well as the development and evaluation of new, innovative techniques. Studies should include:

- assessing bioremediation techniques;
- developing and evaluating new habitat restoration techniques;
- evaluating the role and size of buffers; and
- determining the importance of habitat heterogeneity in the restoration process.

Resulting information should add to the scientific basis for predicting recovery and stability of restored and created systems. The research should generate guidelines for improving best management practices and restoration plans.

Thayer et al. (1996) also stressed improving systems for the transfer of technology and information through the use of all available sources and the application of user-friendly information bases, such as geographic information systems (GIS), which provides the opportunity to amass large quantities of complex, geographically referenced data that provide the potential for making relational observations. Conducting these types of research and analyses would provide the types of information that was needed for this EIS, a better understanding of :

- natural ecosystems and their functional role for individual species and life stages, i.e., linking growth, reproduction, survival and/or overall production rates with particular habitats spatially or temporally (Level 3 and Level 4 information for identifying EFH);
- how sensitive habitats are to fishing and non-fishing impacts;
- how healthy Gulf of Mexico habitats and ecosystems are, to what degree habitats have actually been impacted, and how fast they may recover from perturbations;
- best management practices to mitigate damage or loss to habitats, and to successfully restore habitats, including alterations or modifications to fishing gears and fishing activities.

4.4.2.5 Research on the effects of fishing gear on EFH

In early November 2000, NOAA Fisheries hosted a workshop on the effects of gear on essential fish habitat (EFH) to develop a five-year research program on a multi-agency/institution approach. There was an expectation that some funding would become available from NOAA by the FY2002 budget and some discretionary funding would be available for FY2001. Agencies including the Naval Research Laboratory, the multi-agency Gulf Littoral Initiative program, U.S. Geological Survey (USGS), and Minerals Management Service (MMS) may provide some research or equipment time from their budget to complement that program. At the meeting, it was concluded that the Tortugas North Marine Reserve would be an ideal area to assess recovery from trawling since trawling had occurred in the area since the mid-1950s. The Tortugas Sanctuary, where trawling has been prohibited, could be contrasted to adjacent areas where trawling is occurring.

The SEFSC is funding five projects on the effects of fishing on fish habitat: 1) a study of trawled versus untrawled areas of the western GOM; 2) impacts of lobster traps in the Florida Keys; 3) impacts of finfish traps in the Florida Keys, Puerto Rico, and the Virgin Islands 4) evaluation of trolling on benthic reef populations; and 5) evaluation of the fish population structure of no-use marine reserves versus control areas where fishing is allowed. The results from these projects will add significant information that will assist in the analysis of gear impacts on fish habitat, at least for the areas where the studies occur.

4.4.2.6 Fish-habitat modeling

Mathematical models that describe relationships between habitat and fish production are not generally available because of imprecise definitions of habitat and uncertainty in the relationship between habitat and fish abundance and/or production (Rubec *et al*. in press). Fish abundance varies over areas and habitats as a result of complex interactions of environmental and biological factors. Habitat-use patterns are measurable; however, considerable variation occurs in habitat types and in physical or structural gradients that affect the functional role or importance to a particular species (Clark *et al*. 1999). Two modeling projects, one in Florida and the other in Texas, designed to quantify the relationship between estuarine species and habitat are under way for the GOM. Both use seasonal fishery-independent monitoring of abundance of different life stages in combination with environmental data summarized in seasonal (i.e., salinity, temperature) or overall (i.e., vegetated/non-vegetated, depth) patterns. Both studies use predictive models and Geographical Information Systems (GIS) to test fish-habitat relationships.

The Florida project underway uses spatial habitat suitability index (HSI) models to predict relative species abundance distributions by life stage and season in Tampa Bay and Charlotte Harbor, estuaries on the central west coast of Florida (Rubec *et al*. 1998; Rubec *et al*. in press). HSI modeling first derives a function that relates a suitability index S_i to a habitat variable X_i, for each i-th environmental factor. They use seasonal CPUE from fishery-independent sampling, use seasonal temperature and salinity plus depth as environmental factors, and designate habitat as vegetated or non-vegetated. Suitability functions are expressed as relative density (i.e., CPUE) for each species related to a specific environment. Second, the geometric mean of the S_i values for each cell of mapped variables calculates the HSI value for a cell. Rubec *et al*. (1998, in press) uses ArcView Spatial Analysis to create predicted HSI maps. They build models for Charlotte Harbor and Tampa Bay, and cross reference the models by applying S_i values from Tampa Bay to the conditions in Charlotte Harbor and vice versa. Cross-referenced models perform well for some species or life stages, but poorly for others.

The Texas project uses standard multiple regression to predict relative species abundance distributions by life stage and season in Galveston Bay (Clark *et al.* 1999). They use seasonal CPUE from fishery-independent sampling, use seasonal salinity plus depth as environmental factors, and designate habitat as seagrasses, marsh edge, and non-vegetated. Clark et al. (1999) applied the predictive models to the overall area using ArcView to assess habitat suitability. Cross-referencing the model to Matagorda, San Antonio, and Aransas Bays showed variable, but promising, results.

4.4.2.7 Shrimp fishing effort data

There has been an increase in research efforts in the Gulf attempting to identify the true extent and magnitude of the impacts of shrimp trawl gear. The Gulf of Mexico Shrimp Trawl Fishery Observer Program collects information on target and non-target species, and presently employs 20 full-time observers. The present goal of the program is to characterize shrimp trawl bycatch and evaluate bycatch reduction devices. Over the past ten years (February 1992 through September 2002) a total of 10,674 observer days has been secured by trained observers in the Gulf of Mexico and along the east coast of the United States. Most of these sea days were in waters off Texas (3,569 days) and Louisiana (3,046 days), followed by the west coast of Florida (1,581 days), east coast (1,462 days), and finally the Alabama-Mississippi area (1,016 days). These observer days were accomplished during 1,214 trips, varying in length from 1 to 54 days. From these observer days, trawl data have been collected from over 17,775 individual tows, with several hundred different species being documented from the trawls. In the Gulf, the bycatch species with the highest abundances and total weights have been Atlantic croaker and longspine porgy. Bycatch also includes red snapper, a species considered overfished whose bycatch must be reduced. As with sea days, most of the tows have been from the offshore waters (>10 fm) off Louisiana and Texas.

An experimental electronic logbook program has also been conducted for two years by LGL, covering several vessels (some randomly chosen, some not). The preliminary conclusions are that this type of management tool is much more effective in measuring and locating shrimp fishing effort more precisely than the current trip information program used by NOAA Fisheries (Gallaway et al 2003a, 2003b).

4.5 Conservation recommendations

This section discusses the development of management measures to prevent, minimize or mitigate threats to EFH for actions not under the direct jurisdiction of the Gulf Council or NOAA Fisheries. One of the important elements of mitigating impacts to EFH is that measures are implemented where EFH occurs, and much of it occurs outside of Federal waters, in state waters.

This section relates to two main areas of impacts: impacts from fishing outside of Federal waters (i.e. in state waters) and impacts from non-fishing activities. Threats to EFH from fishing activities that are managed at the state level, and threats from non-fishing activities are described in detail in Section 3.5.2. With respect to these recommendations, this EIS incorporates by reference the very detailed and specific recommendations for non-fishing activities (by project type) that appear in Section 7.2 of the Generic Amendment for Addressing Essential Fish Habitat Requirements (1998) for the seven Gulf of Mexico fishery management plans. This section focuses on new information related to overarching fishery management recommendations, recommendations for specific gears used in state fisheries, and overarching habitat conservation and restoration activities.

4.5.1 Recommendations to mitigate impacts from fishing activities

4.5.1.1 General recommendations

Auster and Langton (1998) reviewed nearly 80 years of research related to effects of fishing on the North American Continental shelf, but were unable to draw any conclusions regarding the overall impacts of fishing. They advise that primary information is lacking to strategically manage fishing impacts on EFH without invoking precautionary measures (specific measures not identified in report). A number of areas were highlighted where primary data are lacking, which would allow better monitoring and improved experimentation, leading to predictive capabilities. These are (taken verbatim from Auster and Langton, 1998):

1. The spatial extent of fishing induced disturbance. While many observer programs collect data at the scale of single tows or sets, the fisheries reporting systems often lack this level of spatial resolution. The available data makes it difficult to make observations, along a gradient of fishing effort, in order to assess the effects of fishing effort on habitat, community, and ecosystem level processes.

2. The effects of specific gear types, along a gradient of effort, on specific habitat types. These data are the first order needs to allow an assessment of how much effort produces a measurable level of change in structural habitat components and the associated communities. Second order data should assess the effects of fishing disturbance in a gradient of type 1 and type 2 disturbance treatments.

3. The role of seafloor habitats on the population dynamics of harvested demersal species. While there is often good time series data on late-juvenile and adult populations, and larval abundance, there is a general lack of empirical information (except in coral reef, kelp bed, and for seagrass fishes) on linkages between EFH and survival, which would allow modeling and experimentation to predict outcomes of various levels of disturbance.

These data, and any resulting studies, should allow managers to regulate where, when, and how much fishing will be sustainable in regards to EFH. Conservation engineering should also play a large role in developing fishing gears which are both economical to operate and minimize impacts to environmental support functions. Because information regarding the effects of fishing on EFH is lacking in most cases, a top research priority should be the examination of the use of research closure areas to detect the effects of fishing on EFH by comparison with fished areas.

The report on the “ecological effects of fishing in marine ecosystems of the U.S.,” produced for the Pew Oceans Commission by Dayton et al. (2002), recommended an expansion of the present definition of “overfishing” to include ecosystem effects (Murawski 2000) and a more flexible/adaptive approach to management, which includes ecosystem-based planning and marine zoning. Additionally, the report calls for the development of ecosystem models for every major ecosystem in the country. To that end, they recommend increased and better monitoring of fisheries including fishery-independent and fishery–dependent monitoring programs, with an emphasis on large scale tagging studies, and requirements for data collection to include regulatory discards and non-endangered bycatch. Fishers should be included as an integral part of the data collection process.

Dayton et al. (2002) also states that regulations designed to protect habitats must be enforceable, and that any reserve areas established to increase fish production be sufficiently large and include ecologically-sensitive areas. Reserve areas established to protect specific features could be much smaller. The report also recommends requiring "vessel monitoring systems" on all commercial and for-hire recreational fishing vessels operating near closed areas, to insure compliance. Additionally, the Pew Oceans Commission report calls for permitting of all U.S. fisheries (requiring both a general and species-specific permit) and for changes in the law to force the forfeiture of permits for some violations (e.g. habitat destruction, repeat fishery violations). The Pew Oceans Commission report suggests that those fishers who destroy highly-productive, structurally-complex habitats be held liable for habitat restoration costs, and that they also be charged with habitat destruction (rather than the typical poaching charge).

A "Symposium on Impacts from Fishery Activities to Benthic Habitats" was held in Tampa, Florida on November 11-15, 2002. The following summary of the meeting is based on a report prepared by Rafe Boulon of the Caribbean Council. The meeting dealt with the impacts of fishing activities on benthic habitats with regard to their role as EFH. Three questions were defined as focal points for the meeting: 1) What do we know about fishing impacts presently? 2) What do we still need to know? 3) What do we know enough about now to take immediate action on?

The majority of papers and posters dealt with the effects of trawling on deep water habitats in the North Atlantic and North Pacific, but some studies of fishing impacts in the Gulf were also presented. Most of the presently available information concerns the direct, short-term impacts of fishing activities, with little known about long-term ecological effects or indirect impacts. Linkages between cause and effect relationships, like trophic cascades, are also poorly understood. One presenter made it clear that if the geologic features of a habitat are destroyed and carrying capacity depends on these structures, changes in abundance and community composition may be permanent (irreversible).

While ecosystem management of fisheries was touted as a goal for managers, a number of problems stand in the way including: too much fishing capacity, difficulties in convincing resource users of "long-term gain for short-term pain" in cost benefit analyses, and the complexity of sustainability issues (biological, ecological, social). There is also a great need for accurate mapping of benthic habitats which occur beyond nearshore, shallow-water areas. Additionally, identification of the level and distribution of fishing activities in relation to benthic habitats is required. Once mapped, habitats can be classified based on their availability (how much there is), their vulnerability (which is based on frequency of natural disturbance) and their risk (measured by frequency of disturbance from fishing activities).

A number of mapping methods were discussed, including digital side scan sonar, multi-beam sonars, hyperspectral methods and AUVs (autonomous underwater vehicles). Each method has its own strengths and weaknesses. In reality, a number of different methods should be used to exploit each method's strengths so as to provide as complete a picture as possible.

In general, we know very little. We still need to know where EFH is, what HAPCs exist, information on indirect effects of fishing activities, and information on ecological linkages (functional relationships) within and between habitats. With the level of knowledge that we have concerning impacts to habitats and the effects on populations of animals, it is clear that fisheries should be at least managed to ensure that disturbance is patchy within habitats. This primarily applies to soft-bottom habitats that have fairly rapid recovery rates and would not work in most hard bottom habitats. There was also mention of such things as zoned application of fishing gear and conservation engineering of fishing gear (reduction of "ecological footprint").

However, the consensus among presenters is that we know a considerable amount concerning what happens within no-take Marine Protected Areas (MPAs) and these probably represent the simplest and best effort for restoring populations of marine organisms and conserving representative habitats for the future. Although there is still limited information on what the effects are in waters surrounding MPAs, the preliminary information coming from places with MPAs is encouraging.

4.5.1.2 Recommendations regarding impacts from fishing activities outside the jurisdiction of the Gulf Council

This EIS has developed a series of alternatives for addressing adverse fishing impacts to EFH in the EEZ, but has not specifically addressed adverse fishing impacts in state waters. Many of the gears with moderate and high impacts to EFH are used only in state waters. Other gears are used in both the EEZ and state waters. The Gulf Council recognizes the actions taken by states to manage gears, and recommends that the states bordering the Gulf of Mexico review the potential adverse impacts of these gears on EFH in state waters, and determine the necessity of additional gear restrictions. At a minimum, it is suggested that states give early consideration to the adoption of the actions listed in the preferred alternative to prevent, minimize or mitigate adverse impacts to EFH (Section 2.2.3). With respect to gears not used in Federal waters, the sensitivities of habitats to fishing gears (Table 3.5.1) indicate the habitat-gear combinations with the highest potential for adverse impacts.

4.5.2 Recommendations to mitigate impacts from non-fishing activities

4.5.2.1 The 1998 Generic Amendment

Very detailed and specific recommendations for the following list of non-fishing threats appear in Section 7.2 of the Generic Amendment for Addressing Essential Fish Habitat Requirements (1998) for the seven Gulf of Mexico fishery management plans, and are incorporated into this EIS by reference. They are listed here in the order that they appear in Section 3.5.3 of this EIS:

Physical Alterations

- Navigation channels and boat access canals
- Docks and Piers
- Boat ramps
- Marinas
- Cables, pipelines, and transmission lines
- Drainage canals and ditches
- Housing developments
- Bulkheads and seawalls
- Transportation
- Impoundments and other water-level controls in wetlands and for watersheds
- Oil and gas exploration and production in coastal marsh, open bay and on the continental shelf
- Other mineral mining/extraction

Water Quality Issues

- Sewage treatment and disposal
- Steam-electric plants and other facilities requiring water for cooling or heating
- Disposal of dredged material
- Water intakes and discharges
- Mariculture/processing

The Generic Amendment (1998) specified that the recommendations listed were not intended to replace or modify any state regulation, but were to be used by the Gulf Council as a set of guidelines for its review or deliberation of specific permits for the above listed activities that may directly impact EFH. As the recommendations presented are essentially "best management practices" for preventing or minimizing impacts to EFH from the listed activities, this EIS does recommend that the appropriate Federal and state agencies incorporate any recommendation that is not currently part of their existing guidelines for approving permits for these activities.

4.5.2.2 NRC (2001)

A report by the NRC (2001) found that the goal of "no net loss" was not being met by mitigation programs nationwide, although progress has been made in the last 20 years and wetland loss rates have been decreasing since the mid-80's. The report recommends using a watershed-based approach which considers the entire ecosystem and its constituent parts, and sets a goal of creating or restoring self-sustaining wetlands. In addition, methods other than the traditional acreage-based approach are now considered in determining impacts of proposed projects. Newer methods like Hydrogeomorphic Assessment and Wetland Rapid Assessment Procedure use a dynamic landscape perspective and account for the ecological functions which mitigation efforts must restore (National Wetlands Mitigation Action Plan 2002). Indicator species other than vegetation are also being used to supplement information regarding mitigation success. This approach has been endorsed by the Army Corps of Engineers (2002).

As a general rule, compensatory mitigation will be considered only after a project has been demonstrated to be water-dependent, has no feasible alternative, is clearly in the public interest, and all significant impacts are found to be unavoidable. In all cases, mitigation shall comply with the definition of mitigation that is provided at 40 CFR 1508.20 of the CEQ Recommendations. Those recommendations define mitigation as a sequential process whereby impacts are avoided, minimized, rectified, reduced over time, or are offset through compensation. As a follow-up to the CEQ recommendations, a Memorandum of Understanding (MOU) titled "Federal Guidance for the Establishment, Use and Operation of Mitigation Banks", between EPA, USCOE, USDA, USDOI, and NOAA was published in the Federal Register on November 28, 1995. The MOU provides policy guidance for the establishment, use, and operation of mitigation banks for the purpose of providing compensatory mitigation for authorized adverse impacts to wetlands.

Despite increasing use of mitigation to offset wetland and other losses, there are situations (e.g., projects affecting large, high-quality seagrass beds) where the affected habitats are of such enormous value that the anticipated adverse impacts cannot be offset. In these situations mitigation should be used only after project relocation or abandonment are fully considered and rejected by the construction/regulatory agency. A review of the scientific literature suggests that few created wetlands become functionally equivalent to nearby natural marshes within 5 years, and may take as long as 20 years to achieve functional equivalency (NRC 2001). Therefore, it should not be assumed that wetlands created at a comparable acreage will fully mitigate the habitat values and functions of the impacted natural wetland.

As a general rule, mitigation that restores previously existing habitats is more desirable and likely to succeed than that which seeks to create new habitat (Army Corps of Engineers 2002). The numerous impacted wetlands that exist in the southeast provide substantial opportunity for wetlands restoration. Restoration may be relatively simple, such as restoring tidal flows to an impounded wetland area, or more complex such as restoring dredged cuts and disposal areas. Restoration of adversely impacted emergent and, to a lesser degree, submerged vegetation is a feasible and recognized option when implemented in association with the services of experienced restoration personnel.

The creation of new wetland habitat involves conversion of uplands or, in some situations, submerged bottom to vegetated wetlands or another desirable habitat such as oyster reef. Generation of wetland habitat should not involve converting one valuable wetland type to another. For example, building emergent wetlands in shallow water is unacceptable unless it can be demonstrated that the site is insignificant with regard to habitat or water quality function(s) or it previously supported wetland vegetation and restoration is desirable in terms of the ecology of the overall hydrological unit (e.g., estuary). Regardless of which option is used (restoration or creation), a quantitative, biologically-based, case-by-case evaluation should be employed to determine the proper amount of mitigation for each acre of habitat destroyed.

Four basic considerations involved in the planning for habitat generation are type of habitat to be created, and its location, size, and configuration. Each of these considerations must be applied to the specific ecological setting and in accordance with the following recommendations:

a. Habitat type - As a general rule the created habitat should be vegetatively, functionally, and ecologically comparable to that which is being replaced. For example, a smooth cordgrass marsh should be created if a smooth cordgrass marsh is eliminated. The principal exception would be those cases where a different habitat is shown to be more desirable based on overall ecological considerations.

b. Location - Except in the case of overriding ecological considerations, the new site should be located as near as possible to the site that would be eliminated. In any event, the new site should be in the same estuarine system as the habitat that is being replaced. The replacement wetland should consider physical implications such as shoaling and existing circulation and drainage patterns.

c. Size - The habitat to be restored or created should be at least twice the (aerial) size of that which would be adversely impacted. This requirement is designed to offset differences in productivity and habitat functions that may exist between established project site wetlands and newly developed replacement wetlands. This size difference also takes into account that the proposed wetlands creation project may wholly or partially fail.

d. Configuration - The configuration of replacement habitats is determined by the ecological setting and physical factors such as existing drainage and circulation patterns. Consideration should be given to maximizing edge habitat and to the needs of desirable biota that may inhabit the site.

e. Monitoring - A monitoring plan for a mitigation project site should be implemented to ascertain success rates and project design viability, at a minimum. Time frames of 3 to 5 years are recommended as minimum time frames to allow for project modifications and re-plantings, if needed.

4.6 Short- and long-term productivity, irreversible and irretrievable commitments

4.6.1 Short-term uses versus long-term productivity

Short-term uses are generally those that determine the present quality of life for the public. The quality of life for future generations depends on long-term productivity; i.e., the capability of the environment to provide resources on a sustainable basis.

To the extent that they impose additional costs and restrict fishing opportunities for fishers, the fishing impacts alternatives will reduce the short term quality of life of those directly impacted. None of the alternatives would be expected to cause long-term loss of productivity of fish resources harvested under the Red Drum, Reef Fish, Coastal Migratory Pelagics, Shrimp, Stone Crab, Spiny Lobster, or Coral FMPs. Fisheries have the potential to reduce long-term productivity of fish and non-fish resources if management standards are not met. Monitoring determines whether fishery control measures are effective and correctly applied to achieve management objectives. All non-no action alternatives are designed to improve long-term productivity. Productivity of fish resources in the Gulf of Mexico are influenced by fishing in state waters and by non-fishing activities, which NOAA Fisheries cannot directly control, in addition to fishing in the EEZ, which NOAA Fisheries and the Gulf Council can directly control.

4.6.2 Irreversible resource commitments

Irreversible commitments of resources are actions that disturb either a non-renewable resource or a renewable resource to the point that it can be renewed only over a long period of time (decades). Loss of biodiversity may be an irreversible resource commitment. For example, extinction of an endangered species would constitute an irreversible loss.

EFH and HAPC alternatives are intended to promote careful review of proposed activities that may affect habitat to assure that the minimum practicable adverse impacts occur on EFH. However, NOAA Fisheries has no direct control over final decisions on such projects. The cumulative effects of these alternatives depend on decisions made by agencies other than NOAA Fisheries, as NOAA Fisheries and the Gulf Council have only a consultative role in non-fishing activities. Decisions made by other agencies that permit destruction of EFH in a manner that does not allow recovery, such as bulkheads on former mangrove or marine vegetated habitats, would constitute irreversible commitments. Irreversible commitments should occur less frequently as a result of EFH and HAPC designations. Accidental or inadvertent activities such as ship groundings on coral reefs or propeller scars on seagrass could also cause irreversible loss.

Alternatives to address adverse fishing impacts are intended to develop measures to reduce impacts to the habitat without unacceptable reduction in gear efficiency or other factors that may make the measures impractical. Absent preemption of management authority in state waters by the Secretary of Commerce, NOAA Fisheries and the Gulf Council have only an advisory role for fishery management in state waters. No irreversible commitments are expected as a result of measures to address adverse fishing impacts. However, the decade-plus recovery time for coral habitats could make unanticipated destruction of coral an irreversible commitment.

5 PUBLIC REVIEW

5.1 Gulf of Mexico Fishery Management Council

Appointed Council Members

Florida	
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James B, Fensom	Panama City, Florida 32401
Julie Morris	Sarasota, Florida 34243
Alabama	
Bobbi Walker	Orange Beach, Alabama 36561
Mississippi	
David Saucier	Pascagoula, Mississippi 39567
H. Kay Williams	Vancleave, Mississippi 39565
Louisiana	
Dr. Maumus F. Claverie, Jr.	New Orleans, Louisiana
Myron James Fischer	Cut-Off, Louisiana 70345
Walter J. Thomassie	Golden Meadow, LA 70357
Texas	
Irby W. Basco	Nederland, Texas 77627
Joseph Hendrix, Jr.	Harlingen, Texas 78550

State and Federal Voting Representatives

Florida Fish and Wildlife Conservation Commission — Tallahassee, FL 32399-1600
Roy O. Williams (designee for Ken Haddad, Director)

Alabama Dept. of Conservation and Natural Resources — Gulf Shores, AL 36535
R. Vernon Minton, Director, Marine Resources Div.
Stevens Heath (occasional designee)

Mississippi Department of Marine Resources — Biloxi, MS 39530
Corky Perret (designee for William Walker)

Louisiana Department of Wildlife and Fisheries — Baton Rouge, LA 70898-9000
Karen Foote (designee for Jimmy Jenkins)

Texas Parks and Wildlife Department — Austin, Texas 78744
Robin Reichers (designee)

NOAA Fisheries, Southeast Regional Office — St. Petersburg, FL 33702
Dr. Roy Crabtree, Regional Administrator
Virginia Fay (designee)
Phil Steele (designee)

Joe Kimmel (designee)

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ATTN: Pete Umbdenstock (GMFMC Panel)	Gulfport, MS 39501
Environmental Defense	
ATTN: Pam Baker (GMFMC Panel)	Corpus Christi, TX 38411
Florida Marine Research Institute	
ATTN: Dr. Paul Carlson (GMFMC Panel)	St. Petersburg, FL 33701-5095
Panama City Boatmen's Assoc.	
ATTN: Bob Zales (GMFMC Panel)	Panama City, FL 32401
Port Aransas Charter Boat Association	
ATTN: Mike Nugent (GMFMC Panel)	Aransas Pass, TX 78335
Southern Offshore Fisheries Association	
ATTN: Robert Spaeth (GMFMC Panel)	Madeira Beach, FL 33708
Southeastern Fisheries Association	
ATTN: Robert P. Jones (GMFMC Panel)	Tallahassee, FL 32303-6287
Stream Companies	
ATTN: David Richard (GMFMC Panel)	Lake Charles, LA 70602
Texas Shrimp Association	
ATTN: Julius Collins (GMFMC Panel)	Brownsville, TX 38521
University of South Alabama	
ATTN: Dr. Robert Shipp (GMFMC Panel)	Mobile, AL 36688

5.2 Federal Agencies

US Army	
Asst Secretary for Installations and Environment	Washington, D.C. 20310-0110
Asst Secretary for Civil Works	Washington, DC 20314
Galveston District	Galveston, TX 77553-1229
New Orleans District	New Orleans, LA 70160-0267
Vicksburg District	Vicksburg, MS 39183
Mobile District	Mobile, AL 36628-0001
Jacksonville District	Jacksonville, Florida. 32232-0019

US Navy	
Asst Secretary for Installations and Environment	Washington, D.C. 20350-1000
Undersea Warfare Center Division (NAVSEA)	Newport, RI 02841

US Air Force	
Asst Secretary for Installations, Environment and Logistics	Washington, D.C. 20330-1690
US Marine Corps	
Dep. Commandant for Installations and Logistics	Washington DC 20380
US Department of Energy	Washington, DC 20585
US Department of Interior	
US Fish and Wildlife Service	Washington, D.C. 20240
Minerals Management Service	
Gulf of Mexico Region	New Orleans, LA 70123-2394
Headquarters	Herndon, VA 20171
US Geological Survey	
National Wetlands Research Center	Lafayette, LA 70506
Comprehensive Everglades Restoration	Vero Beach, FL 32960-3559
Department of State	
Bureau of Oceans & Intl. Env. & Scientific Affairs	Washington, DC 20520
Department of Transportation	
Federal Highway Administration	Washington, D.C. 20590
Department of Homeland Security	
U.S. Coast Guard	Washington, DC 20593
Seventh Coast Guard District	Miami FL 33131-3050
Eighth Coast Guard District	New Orleans, LA 70130-3396
Federal Energy Regulatory Commission	Washington, D.C.
Atlanta Regional Office	Atlanta, GA 30340
Environmental Protection Agency	
Office of Water (4101M)	Washington, D.C. 20460
Region 4 Environmental Review Coordinator	Atlanta, GA 30303-3104
Region 6 Environmental Review Coordinator	Dallas, Texas 75202
Department of Commerce, NOAA	
NOAA Fisheries, SE Fisheries Science Center	Miami, FL 33149
NOAA Fisheries, Alaska Regional Office	Juneau, AK 99801
NOAA Fisheries, Headquarters	Silver Spring, Maryland 20910
NOAA Fisheries, Habitat Ecology Team	Santa Cruz, CA 95060
Office of Ocean & Coastal Resource Mgmt	Silver Spring, Maryland 20910

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Coastal Zone Management	Austin, TX 78701-1495
Commission on Environmental Quality	Austin, TX 38711
Parks and Wildlife Department	Austin, TX 78744-3218
Department of Transportation	Austin, TX 78701-2483
Sea Grant College Program	College Station, Texas 77845
Louisiana	
Office of the Governor	Baton Rouge, LA. 70804-9004
Coastal Zone Management	Baton Rouge, LA 70802
Department of Natural Resources	Baton Rouge, LA 70804-9396
Department of Wildlife and Fisheries	Baton Rouge, LA 70898-9000
Sea Grant Program	Baton Rouge, LA 70803-7507
Mississippi	
Office of the Governor	Jackson, MS 39205
Coastal Zone Management	Biloxi, MS 39530
Department of Marine Resources	Biloxi, MS 39530
Department of Environmental Quality	Jackson, MS 39109
Mississippi-Alabama Sea Grant Consortium	Ocean Springs, MS 39566-7000
Alabama	
Office of the Governor	Montgomery, Alabama 36130
Coastal Zone Management	Montgomery, Alabama 36130
Department of Conservation and Natural Resources	Dauphin Island, AL 36528
Department of Environmental Management	Montgomery, AL 36130
Florida	
Office of the Governor	Tallahassee, FL 32399-2100
State Clearinghouse	Tallahassee, FL 32399-2100
Department of Environmental Protection	Tallahassee, FL 32399
Fish & Wildlife Conservation Commission	Tallahassee, FL 32399-1600
Department of Agriculture and Consumer Services, Division of Aquaculture	Tallahassee, FL 32301
Coastal Zone Management	Tallahassee, FL 32399-3000
Grant Program	Gainesville, FL 32611-0400

5.4 Non-Governmental, Individuals and other Organizations

South Atlantic Fishery Management Council	Charleston, SC 29407

National Estuary Programs	
Coastal Bend Bays & Estuaries Program	Corpus Christi, Texas 78401
Galveston Bay Estuary Program	Webster, TX 77598
Barataria-Terrebonne National Estuary Program	Thibodaux, LA 70310
Mobile Bay National Estuary Program	Mobile, AL. 36615
Tampa Bay Estuary Program	St. Petersburg, FL 33701
Sarasota Bay National Estuary Program	Sarasota, Florida 34236
Charlotte Harbor National Estuary Program	N. Fort Myers, Florida 33917-3909
Coastal Conservation Association	Houston, TX 77024
Coastal Conservation Association	Tallahassee, FL 32301
Destin Charterboat Association	Destin, FL 32550
Ecology & Environmental, Inc	Pensacola, FL 32501
Geo-Marine, Inc	Plano, TX 75074
Gulf Coast Conservation Association	Houston, TX 77056
Gulf Restoration Network	New Orleans, LA 70112
Gulf States Marine Fisheries Commission	Ocean Springs, MS 39566-0726
Gulf & South Atlantic Fisheries Foundation	Tampa, FL 33609-2447
Institute for Fisheries Resources	San Francisco, CA 94129-0196
Louisiana Shrimp Association	Houma, LA 70360
Louisiana Wildlife Federation	Baton Rouge, LA 70896
Marine Resource Science	Oakland Park, FL 33309
Monroe County Commercial Fisherman, Inc	Marathon, FL 33050
National Audubon Society	New York, NY 10003
Natural Resources Defense Council	New York, NY 10011
Oceana, Inc	Washington, DC 20037
Ocean Conservancy	St. Petersburg, FL 33701
Ocean Conservancy	Washington, DC 20036
Organized Fisherman of Florida	Cocoa, FL 32923
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