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FISHERY ECOSYSTEM PLAN OF THE SOUTH ATLANTIC REGION
VOLUME IV: THREATS TO THE SOUTH ATLANTIC ECOSYSTEM AND RECOMMENDATIONS

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ABBREVIATIONS AND ACRONYMS

ABC	Allowable Biological Catch
ALS	Accumulative Landings System
ACCSP	Atlantic Coastal Cooperative Statistics Program
B	A measure of fish biomass either in weight or other appropriate unit
BMSY	The biomass of fish expected to exist under equilibrium conditions when fishing at FMSY
BOY	The biomass of fish expected to exist under equilibrium conditions when fishing at FOY
BCURR	The current biomass of fish
C	Catch expressed as average landings over some appropriate period
DSEIS	Draft Supplemental Environmental Impact Statement
EFH	Essential Fish Habitat
EFH-HAPC	Essential Fish Habitat - Habitat Area of Particular Concern
EIS	Environmental Impact Statement
ESA	Endangered Species Act of 1973
F	A measure of the instantaneous rate of fishing mortality
FCURR	The current instantaneous rate of fishing mortality
FMSY	The rate of fishing mortality expected to achieve MSY under equilibrium conditions and a corresponding biomass of BMSY
FOY	The rate of fishing mortality expected to achieve OY under equilibrium conditions and a corresponding biomass of BOY
FEIS	Final Environmental Impact Statement
FMU	Fishery Management Unit
MARMAP	Marine Resources Monitoring Assessment and Prediction Program
MFMT	Maximum Fishing Mortality Threshold
MMPA	Marine Mammal Protection Act of 1972
MRFSS	Marine Recreation Fisheries Statistics Survey
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSST	Minimum Stock Size Threshold
MSY	Maximum Sustainable Yield
NEPA	National Environmental Policy Act of 1969
OY	Optimum Yield
RIR	Regulatory Impact Review
SEDAR	Southeast Data, Assessment and Review
SFA	Sustainable Fisheries Act
SIA	Social Impact Assessment
SPR	Spawning Potential Ratio
SSR	Spawning (biomass) per Recruit
TMIN	The length of time in which a stock could be rebuilt in the absence of fishing mortality on that stock
TAC	Total Allowable Catch

Glossary

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6.0 Threats to the South Atlantic Ecosystem

6.1 Adverse impacts of non-fishing activities

The waters and substrate that comprise essential fish habitat (EFH) as defined by the Magnuson- Stevens Fishery Conservation and Management Act (MSFCMA), and under jurisdiction of the South Atlantic Fishery Management Council (SAFMC), are diverse, widely distributed, and closely affiliated with other aquatic and terrestrial environments. These characteristics make them readily susceptible to a large number of human activities.

The Essential Fish Habitat (EFH) Interim Final Rule (Federal Register 62 FR 244) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The following definitions apply for interpreting the definition of the EFH rule:

- <u>Waters</u> include aquatic areas and their physical, chemical, and biological properties that are used by fish and invertebrates, and where appropriate may include areas historically used by fish and invertebrates;
- <u>Substrate</u> includes sediment, hard bottom, structures underlying the waters, and biological communities;
- <u>Necessary</u> means the habitat required to support a sustainable fishery and a healthy ecosystem; and
- <u>Spawning, breeding, feeding, or growth to maturity</u> covers species' full life cycle.

Fish habitat is the geographic area where the species occurs at any time during its life. This area can be described by ecological characteristics, location, and time. EFH includes waters and substrate that focus distribution; e.g., coral reefs, marshes, or submerged aquatic vegetation (SAV), and other characteristics that are less distinct such as turbidity zones, water quality, and salinity gradients. Habitat use may change or shift over time due to climatic change, human activities and impacts, and/or other factors such as change with life history stage, species abundance, competition with other species, and environmental variability in time and space. The type of habitat available, its attributes, and its functions are important to species productivity, diversity, health, and survival.

Convention for Threats Identification

The ecological requirements for managed species and biotic communities, including identification of EFH, are addressed in this document. Threats to those habitats are described in terms of those that generally occur landward of the shoreline (Threats to Estuarine Processes) and those that occur oceanward of the shoreline (Threats to Offshore Processes). Threats to Estuarine Processes include but are not limited to agriculture; aquaculture; silviculture; urban/suburban development; commercial and industrial activities; navigation; recreational boating; mining; hydrologic modifications; transportation projects; and natural events and global change. Threats to Offshore Processes include navigation; dumping; offshore sand and mineral mining; oil and gas exploration, development, and transportation; commercial and industrial activities; and natural events and global change. A more comprehensive list of individual activities that may be considered as threats is provided in Section 6.3.17.

Every reasonable effort was made to identify the principal non-fishing and fishing-related threats to EFH and to provide examples and information concerning the relationship between threat-related activities and EFH. Other information sources and examples undoubtedly exist and related studies are underway or are in various stages of publication. Accordingly, the following discussion is a starting point for the identification of threats to EFH. While it meets the strict time limitations imposed by the MSFCMA, regular updating is required to ensure comprehensive and current coverage of the topic addressed.

6.1.1 Freshwater/estuarine/inshore processes

Many species of the south Atlantic region are dependent during at least some life history stages on near-shore waters vulnerable to impacts from land-based sources. Especially vulnerable are species or species groups that require estuaries or freshwater tributaries as primary larval or post-larval habitat. In the Southeast, these species include anadromous fish such as striped bass, blueback herring, alewife, American shad, hickory shad, and sturgeons; and brackish species including Atlantic menhaden, summer and southern flounder, red drum, spot, croaker, weakfish, penaeid shrimp, blue crab, and others (Epperly and Ross 1986).

Nearshore EFHs at risk from land-based impacts include submerged shellfish beds; subtidal and intertidal mudflats and shell hash; SAV beds, including eelgrass (*Zostera marina*), Cuban shoal grass (*Halodule wrightii*), and widgeon grass (*Ruppia maritima*); tidal freshwater forested wetlands dominated by tupelo-cypress communities (*Taxodium distichum*, *Nyssa aquatica*), and emergent tidal marshes including both saltmarshes dominated by smooth cordgrass (*Spartina alterniflora*) and brackish marshes dominated by black needlerush (*Juncus roemerianus*). These habitats may be affected both by direct destruction and by degradation of water quality or other factors such as hydrologic modification. Elimination or degradation of wetlands not immediately adjacent to EFH also may diminish the quality and productiveness of downstream estuaries.

The precise relationship between fishery production and habitats is undetermined. Accordingly, the exact degree to which habitat alteration has affected fishery production is also unknown, but is thought to be substantial. Turner and Boesch (1987) assembled and examined evidence of the relationship between the extent of wetland habitats and the yield of fishery species that depend on coastal bays and estuaries. The evidence examined show that fishery stock losses follow wetland losses and fishery stock gains follow wetland gains. While most of the studies were related to shrimp production, other fisheries are likely follow this trend.

In the southeastern U.S., the dominant sources of land-based impacts include major land-disturbing activities such as agriculture, silviculture, and residential and commercial development. The following discussions characterize major threats in the coastal zone of the southeast, summarize ways that EFH is impacted, and characterize the current extent of such impacts. Impacts can occur at three scales: immediate watersheds of EFH; broader watersheds of important estuarine nurseries; and distant or indirect impacts mediated through more widespread movement of water and its chemical and physical make-up.

6.1.1.1 Agriculture

Agriculture in the Southeast has undergone dramatic changes over time. Most operations were at one time individual and small-scale enterprises, but in recent years have transformed into highly integrated, large-scale industries. Besides the extensive conversion of wetlands to crop and animal production, the most dramatic change in southern agriculture is the large scale expansion in animal production that has occurred during the last decade. The most dramatic increases have occurred in corporate hog operations in North Carolina. According to North Carolina Agricultural Statistics, the 1996/1997 hog numbers (8,969,200) for the 44 coastal counties are more than quadruple the 1986 numbers (2,117,800) for the same area. At the same time, the number of hog farms has declined precipitously, by a factor of three.

Other southeastern states have not yet experienced the same increase in swine herds. South Carolina's coastal counties, in fact, experienced a net reduction in swine herds from 374,000 head in 1986 to 194,900 head in 1996 (South Carolina Agricultural Statistics). Georgia had a similar decrease in the coastal plain counties, decreasing from 400,911 head in 1987 to 317,795 head in 1992 (Georgia Agricultural Statistics). Florida numbers experienced a decline in Atlantic watersheds from about 23,541 head in 1987 to 12,482 head in 1992 (Florida Agricultural Statistics). Part of the reason for the differences in hog production among the states is the development of industrial hog-growing technologies in North Carolina, plus differences in state regulatory programs. South Carolina, for instance, recently adopted very stringent and restrictive new laws governing hog-growing operations.

Poultry production, a second major agricultural animal product, has also increased substantially in the Southeast. Again, North Carolina leads the nation in several poultry categories. In 1996, 313,735,000 birds were produced in coastal North Carolina; up from 45,588,966 birds in 1986. South Carolina coastal counties also showed a significant increase in production over this decade: 57,834,000 birds were produced in 1986 and 140,038,000 in 1996. The increases in the Georgia and Florida Atlantic coastal counties were much more moderate from 1987 to 1992, with production rates of 12,907,265 to 15,438,031 birds, and 2,780,706 to 2,886,335 birds, respectively (all data from state agricultural statistics).

Patterns in cropland use also have been in flux. In the North Carolina coastal plain, harvested cropland has remained almost static during the past decade, at about three million acres. However, fertilizer use has increased from 848,927 tons in 1986 to 2,006,251 tons in 1996 (not including swine and other animal waste land application). During the same period, South Carolina has experienced a net decrease in harvested acreage in the coastal plain, from 1,759,162 acres to 1,589,420 acres, but a net increase in fertilizer usage of about 38 percent to 331,597 tons. Harvested cropland along the Georgia coast is up slightly, to about 900,000 acres in 1992. Comparable data on fertilizer usage are not yet available. Harvested cropland in the Florida Atlantic coastal plain is down from about 1.1 million acres in 1992 to 675,081 acres in 1996. (All data from state agricultural statistics).

The overall pattern in crop production is one of great intensification of use on a fairly stable land base. Large increases in fertilizer usage and manure-based nitrogen fluxes (from surface and groundwater and from airborne sources) have occurred during the last decade in at least some southeastern states, including watersheds that were already artificially enriched.

Nutrient pollution can result in cascading ecological and economic impacts, including fish kills due to oxygen depletion, seagrass die-offs, excessive and sometimes toxic algal blooms, changes in marine biodiversity, increases in human illnesses, and loss of tourism (NRC 2000). For example, in southeast Florida nutrient inputs to Lake Okeechobee from central Florida agriculture activities (primarily sugar) are then discharged to important estuaries including the St. Lucie estuary. Timed releases associated with flood control activities result in large quantities of nutrient-laden water inputs to the St. Lucie estuary. Between 2004 and 2005, it is estimated that approximately 320 billion gallons of this water was diverted to the St. Lucie estuary. Many researchers have suspected that algal blooms and resulting fish kills in 2005-2006 were a result of this activity.

<u>Potential Threats to EFH from Agriculture</u>

Potential threats include: conversion of wetlands to agricultural lands, or for farm related purposes such as roads and irrigation ponds; direct and non-point source discharge of fill, nutrients, chemicals, and surface and ground waters into streams, rivers, and estuaries; hydrologic modification of ditches, dikes, farm ponds and other similar structures and water control devices; damage to wetlands and submerged bottoms by livestock grazing and/or movement; and cumulative and synergistic effects caused by association of these and other related activities.

Certain agricultural activities present a threat to EFH in the southeast. The major components of this threat include wetland conversion, nutrient over enrichment with subsequent deoxygenation of surface waters, shading by excessive algae and plant growth, and stimulation of toxic dinoflagellates; sedimentation; and delivery of toxicants into sensitive waters. Agriculture (including silviculture) accounted for 87 percent of all wetland losses observed nationally between the mid 1950's and mid 1970's (Tiner 1984). This loss has been estimated at more than 458,000 acres per year between the mid 1950's and mid 1970's in the coterminous U.S. (Tiner 1984). The most extensive losses observed in the southeast were in Florida and North Carolina where agricultural drainage continues to destroy large tracts of wetlands (Tiner 1984). Current agriculture conversion statistics for the southeast show that:

- During the mid-1970s to the mid-1980s “Florida showed a net wetland loss of 260,000 acres, mainly from the destruction of palustrine wetlands. Two-thirds of the loss of palustrine wetlands was attributable to agricultural development...” (Hefner et al 1994).

- “Between the mid-1970s and mid 1980s, more than 100,000 acres of freshwater forested wetlands in Georgia were destroyed, mostly because of conversion to land uses such as agriculture” (Dahl et al 1991).
- Between 1982 and 1989, South Carolina lost 155,500 acres, of this amount agriculture was responsible for 28 percent (Dahl 1997).
- In North Carolina about one-third of the wetland alteration in the coastal plain has occurred since the 1950s. Of this amount, agriculture was responsible for about 42 percent (Cashin et al 1992).

Excessively enriched waters often do not support desirable species or populations of fish and invertebrates. They also may not support food chain and other ecological assemblages needed to sustain desirable species and populations. When overly abundant, nutrients such as nitrogen (ammonia) and phosphorus may degrade or eliminate EFH and its flora and fauna through several processes. Most problematic of these is the process whereby dissolved oxygen in the water is reduced by decaying plant life that prospered under nutrient rich conditions. In severe oxygen depletion situations fish and invertebrates may suffocate from oxygen deprivation.

Nutrient enrichment may also lead to direct toxicity when toxic organism populations “bloom” or become excessively large -- situations that are becoming more prevalent and which are discussed in detail in subsequent sections. Although affected by acidity, water temperature, and other factors, total ammonia concentrations in excess of about 2 mg/L normally exceed the chronic exposure level for fish (Mueller and Helsel 1996). In alkaline water at high temperature, the criteria may be exceeded by total ammonia concentrations of less than 0.1 mg/L. The natural conversion of ammonia to nitrate in streams removes oxygen from water and, therefore, may also harm fish (Mueller and Helsel 1996). While less problematic in estuarine and marine environments, phosphorus is a major factor in nutrient enrichment and eutrophication of freshwater systems. There are no minimum discharge standards for phosphorus; however, the U.S. EPA recommends that phosphates should not exceed 0.05 mg/L when discharged into streams entering lakes and reservoirs (Muller and Helsel 1996). Since freshwater systems may be used directly by anadromous fish, and they may also discharge into coastal waters, the quality of these waters has considerable bearing on many commercially and recreationally important aquatic resources and their habitats, including EFH. The nutrient inputs from central Florida agriculture (i.e., sugar) to Lake Okeechobee, the St. Lucie estuary, and Indian River Lagoon are suspected to have caused algal blooms, seagrass die-offs, and notable bivalve and fish kills in 2005-2006. In addition, the nutrient inputs are also suspected to have adversely impacted reefs located just outside the St. Lucie inlet (e.g., Peck’s reef).

In extreme situations living resources may be temporally or permanently displaced due to shifts in the aquatic food web, or by the physical presence of certain plant life. Excessive plant growth may also impede requisite functions (e.g., photosynthesis) of desirable plant life, hence EFH, as in the case of SAV where leaves may become covered with dense growths of algae, diatoms, and other biota such as bacteria and fungi.

Agriculture is believed to be the single largest contributor of nutrients into southeastern watersheds. The largest human additions of nitrogen result from an increased use of inorganic fertilizers (NRC 2000). In the Tar-Pamlico Estuary Basin in North Carolina, agriculture is responsible for approximately 45 percent of total nitrogen loading to the estuary, and 55 percent of phosphorus loading (NCDEHNR 1997a). An additional 33 percent of nitrogen and 17 percent of phosphorus comes from atmospheric sources that include, but is not limited to agriculture (NCDEHNR 1994, 1997a). In the adjacent Neuse River Basin, 54 percent of nitrogen is estimated to arise from agricultural sources (NCDEHNR 1993, 1997b). These two tributaries discharge into Pamlico Sound, the nation's second largest estuary, and the largest in the Southeast.

Animal production is a threat to southeastern estuarine nutrient balances. The current usual management practice for manure from swine and other confined domestic mammals is storage and treatment in anaerobic lagoons followed by land application. This process relies on volatilization of nitrogen to account for roughly 80 percent of the total produced nitrogen, with concomitant downwind delivery in a zone of influence of roughly 100 kilometers (Rudek 1997). Airborne deposition of nitrogen into coastal waters in the region has been verified from field data to be a major source of enrichment in a number of southeastern estuaries. The most complete work at this time is focused on the Neuse River Estuary in North Carolina, where primary production was boosted two to three times by atmospheric deposition at ambient levels (Paerl et al 1995a, 1995b). Actual plant uptake by crops on land-application fields accounts for no more than 10 percent of nitrogen use. Surplus nitrogen is delivered to shallow groundwater systems which, in turn, feed warm-season surface flows into adjacent streams and rivers. Thus, the vast majority of this material is redeposited on land and in surface waters.

Studies by Barker (1997) and Barker and Zublena (1995) also show that many North Carolina coastal counties are receiving swine-based nitrogen and/or phosphorus at levels in excess of total crop-plant growth needs. This analysis actually underestimates the problem, because it considers only direct land-applied nutrients and ignores swine-based atmospheric deposition in these counties. A report compiled for Senator Tom Harkin (D-IA) analyzed manure production patterns nationally by county and found zones of very high production in coastal North Carolina and in individual counties in the other three southeastern states. That document also reports excessive production above crop growth needs in many areas (Minority Staff 1997).

A recent estimate of agricultural emissions of ammonia from the North Carolina coastal plain is about 200.3 million pounds of nitrogen from animal waste, and 15 million pounds of nitrogen from fertilizers. Hogs alone contribute about 135 million pounds of nitrogen emissions in coastal North Carolina; larger than the entire National Atmospheric Deposition Program estimate of airborne deposition from all sources in the North Carolina coastal plain (Rudek 1997).

In response to nutrient enrichment problems and public concern, the North Carolina General Assembly has moved to impose a two-year moratorium on the development of new or enhanced hog farms, pending the replacement of current anaerobic lagoon technology with a more acceptable alternative.

High nutrient loadings also have been documented in other southeastern river basins and estuaries. Among seven river basins in Florida and Georgia examined recently by the U.S. Geological Survey, two in Georgia (the Altamaha and the Satilla) were found to be very high in nitrogen inputs at 5,470 (kg/yr)/km^2 and 5,430 (kg/yr)/km^2, respectively. Animal waste was the dominant source of nitrogen loading in both basins. Fertilizer was the biggest source in the St. Johns River Basin in Florida, and the Ogeechee Basin in Georgia. The most dominant sources of nutrient loading are non-point-source in origin, and predominantly agricultural (USGS 1997).

The National Water Quality Assessment Program is also examining the Santee Basin and nearby coastal drainages in South Carolina. Data from 1994 covering 24,868 square miles in South and North Carolina are being considered for this analysis. Although definitive information is not yet available, nutrient pollution of lakes and the rivers themselves has been identified as a major water quality issue for the program (USGS 1994). The first reports from this program are now available and include an annotated bibliography of water quality databases and recent publications on the water quality of the region (Abrahamsen et al. 1997).

Impacts of sediment from non-point-sources including agriculture and silviculture remain at the top of the water pollution list nationally (USEPA 1990) and in the southeastern states (NCDEHNR 1996b). While sediment-based impacts are typically considered to be most acute in freshwater systems, sediment pollution can also threaten EFH. Because sedimentation is a natural process in most aquatic systems it is generally not problematic except where deposition rates vastly exceed ambient conditions. In these situations, benthic animals and plants and demersal fishes that are unable to adjust or relocate may be buried or undergo disruption in growth and reproduction. Lethal and non-lethal effects of turbidity include ingestion of non-food particles by shellfish and polychaete worms, clogging of pores and gills, erosion of gills and other apparatuses such as fins, tentacles, and cilia that may be used for locomotion and feeding, burial of eggs and juveniles, and burial of substrates that may be needed for cover, attachment, and reproduction. In areas that support SAV, primary production levels may be reduced where light penetration is limited by increased turbidity.

While generally less important as a potential threat to EFH in the south Atlantic region, sediment deprivation may be locally troublesome since subsidence and erosion of wetlands and other habitats may result. Impounded coastal wetlands used for rice culture and other agricultural crop production in North Carolina, South Carolina, and Georgia are notable since large areas have been permanently altered even though tidal flow has been restored in many cases. In the Altamaha River Estuary in Georgia vast areas of freshwater and brackish tidal forested wetlands have been converted to emergent wetlands following construction of dikes and ditches that interrupted both deposition of alluvial materials and other processes.

Sediment pollution from agriculture is widespread in the coastal zone of the southeastern states. For example, North Carolina's "303d list," the listing of degraded water bodies required to be compiled by the Clean Water Act, contains an array of coastal streams degraded at least in part by agricultural sediment pollution. These include tributaries of the Northeast Cape Fear River and Black River; Potecasi Creek (Chowan River); Trent River (Neuse Basin); Little River (Pasquotank Basin); Tranter's, Grindle, Conetoe and Town creeks (Tar-Pamlico Basin); and Newport River (NCDEHNR 1996a).

Pathogens from agricultural sources also threaten EFH, especially shellfish waters. The biggest single threat is probably poorly managed animal waste. A secondary source is land-disturbing activity related to putting new land into agricultural production. This may result in additional delivery of fecal coliform bacteria in quantities of potential concern.

The most dramatic cases of contamination of EFH from agricultural sources include spills of animal waste into coastal watersheds. North Carolina has suffered a number of recent spills, including many in the summer of 1995. A large swine lagoon rupture in 1995 spilled about 25 million gallons of waste into the New River Estuary causing severe anoxia, stimulating toxic algal blooms, and elevating fecal bacteria concentrations in both the receiving waters and sediments. Effects of this event persisted for over 61 days (Burkholder et al. 1997). Similar, but smaller, events were documented into tributaries of the Cape Fear River Estuary, North Carolina, from both swine and poultry sources. Impacts included large nutrient delivery, algal blooms, and contamination with huge loads of fecal bacteria; including pathogenic *Clostridium perfringens* (Mallin et al. 1997). This study documented 30 animal waste spills in North Carolina in 1995 and 1996. Bacteria from other agricultural sources also may contribute to contamination of shellfish waters. As wetland landscapes are developed for agriculture, offsite water delivery is enhanced (Skaggs et al 1980). Many scientists believe that this hydrologic effect may contribute to elevated fecal coliform counts in receiving waters. This is suggested by preliminary studies in Otter Creek, Broad Creek, and the South River, North Carolina (J. Sauber, personal communication).

The variation in the scope and composition of agricultural non-point-source discharges and in the receiving waters creates an almost endless range of possible effects on aquatic resources, including EFH. Exposure of estuarine finfish and shellfish to toxic levels of insecticides, herbicides, and fungicides may occur, resulting in significant declines in populations Scott (1997). Sublethal effects also are evident. For example, many compounds released by agricultural operations may adversely affect hormones such as estrogen and androgen that are linked to immune suppression (Scott 1997). These compounds usually do not kill the animal immediately, but reduce its life span and often its ability to reproduce.

Agricultural compounds that have been identified as having properties damaging to aquatic organisms include the commonly used herbicides aldicarb and atrazine and others such as, endosulfan, chlorpyrifos, and trace metals such as copper and mercury.
The enormous variation in the scope and composition of agricultural nonpoint source discharges and in the environmental nature of the receiving waters creates an almost endless range of possible effects on aquatic resources, including EFH. As noted in Scott (1997):

"Agricultural nonpoint source (NPS) runoff may result in significant discharges of pesticides, suspended sediments and fertilizers into estuarine habitats adjacent to agricultural areas or downstream from agricultural watersheds. Exposure of estuarine finfish and shellfish to toxic levels of insecticides, herbicides, and fungicides may occur, resulting in significant declines in field populations. Development of new management techniques such as Integrated Pest Management (IPMs), Best Management Practices (BMPs), and Retention Ponds (RP) are risk management tools which have been used to reduce contaminant risk from agricultural NPS runoff."

In association with Scott's (1997) observations, the National Ocean Service (NOS), Charleston Laboratory examined effects of NPS agricultural runoff on living marine resources in an attempt to define impacts on fishery resources and to develop risk reduction strategies to minimize/mitigate impacts. Investigations involving coastal estuarine ecosystems in South Carolina examined several sites used for vegetable farming (e.g. tomatoes, cucumbers and snap beans), where varied levels of risk reduction strategies were employed. The studies used grass shrimp (*Palaemonetes pugio*) and the mummichog (*Fundulus heteroclitus*) as well as other macropelagic populations. These two species represent more than 85 percent of the total macrofaunal (>15mm) densities in small tidal creek nursery grounds in South Carolina and they are important due to their role in estuarine food webs. The studies demonstrated that pesticide exposure caused fish and invertebrate abundance reductions and mortality. Comparison of field results with laboratory toxicity tests clearly established that implementation of an integrated risk reduction strategy can significantly reduce NPS agricultural pesticide runoff. At intensively managed (IPM, BMPs, and RP) agricultural sites where strict NPS control techniques were administered, instream pesticide (azinphosmethyl, endosulfan, and fenvalerate) levels were reduced by 89-90 percent (Preceding from Scott 1997).

According to Scott (1997) the commonly used herbicides aldicarb and atrazine are potential endocrine disrupting chemicals (e.g. compounds that adversely affect hormones such as estrogen and androgen) and are linked to immune suppression. A 1992, Texas investigation found atrazine at concentrations > 60 ug/L in 98 percent of surface water samples that were taken on an annual basis. Laboratory toxicity tests of atrazine effects on estuarine phytoplankton revealed that chronic, low level atrazine exposure over multiple generations lead to enhanced sensitivity of phytoplankton and combined alachlor and atrazine exposure caused greater than simple additive toxicity in phytoplankton (Scott 1997).

The chronic effects of agriculture derived non-point source discharge have been extensively studied in Florida where impacts are occurring on a large scale basis. Essentially all of Florida Bay has undergone significant and undesirable biological, chemical, and physical change due to large scale agricultural practices, including hydrologic modification, in the Everglades. While these changes are occurring primarily in waters that lie outside of SAFMC jurisdiction, they are notable because of their size, magnitude, and complexity. Two basic lessons from the Everglades/Florida Bay situation also have application in watersheds found along the south Atlantic. They are: (1) the chronic environmental and ecological effects of regional agricultural practices may be extremely large and devastating and (2) the financial costs associated with analyzing and remedying these effects are likely to be enormous and possibly ineffective.

The factors associated with EFH degradation by agricultural related hypoxia are only poorly understood, but are of concern. Thus far, the extensive hypoxic zones and conditions observed in the Gulf of Mexico have not occurred the south Atlantic region. Exceptions include relatively small, yet harmful, localized events in portions of North Carolina and South Carolina. In this region, North Carolina’s estuarine waters are particularly vulnerable due to their shallow depths, poor flushing characteristics, and the abundance of hog farms found in the coastal zone. Although the most conspicuous effect of hypoxia is the mortality of larger fish and possibly invertebrates, even greater harm may be occurring with sensitive larval and juvenile forms since they are most vulnerable to oxygen depletion and other forms of environmental perturbation.

6.1.1.2 Aquaculture

Potential Threats to EFH from Aquaculture

Potential threats include: dredging and filling of wetlands and other coastal habitats and other modification of wetlands, submerged bottoms, and waters through introduction of pens, nets, and other containment and production devices; introduction of waste products and toxic chemicals; and introduction of exotic organisms; in addition to competition with wild stock for food sources.

Nationwide aquaculture is a vibrant industry with the annual value of product sold exceeding $866 million in 2005, although revenues have declined somewhat over the past 10 years (U.S. Department of Agriculture 2006). Within the Atlantic Southeastern U.S., the annual value of product sold amounted to over $94 million in 2005, with Florida ($57.4 million) and North Carolina ($24.7 million) leading Georgia ($4.5 million) and South Carolina ($4.7 million). All aquaculture facilities in these states are located either on uplands or in coastal waters and no offshore aquaculture farms presently exist in the Atlantic Southeastern U.S. The primary aquaculture operations in the Atlantic Southeastern U.S. are shellfish farms (including hatcheries for production of seed stock), production of marine species in closed-recirculation systems, and production for enhancement of native fishery stocks.

The growing demand for seafood reflects both the growth of the U.S. population and the increased awareness of health benefits that result from a diet that includes seafood (Nesheim and Yaktine 2007). Currently, more than 80 percent of the U.S. seafood supply is imported, with over 40 percent of that amount coming from foreign aquaculture operations. Considering the substantial economic incentive to increase aquaculture production in the U.S. and the gradual elimination of technological barriers, expansion of the domestic aquaculture industry is expected over the next decade. Offshore areas may receive particular attention for development (Stickney et al. 2006).

Aquaculture and Fishery Habitats

Aquaculture has long been a source of human food. Within the last century, the technology of aquaculture has changed dramatically allowing application of semi-intensive and intensive farming systems. While this concentrates aquaculture activities to relatively small spatial areas and sets the stage for potential environmental conflicts, these concerns can be mitigated through appropriate management measures (Marine Aquaculture Task Force 2007). Balancing the demand for seafood and economic growth with the need to maintain coastal and marine ecosystems is a challenge that aquaculture accepts.

Nash et al. (2005) used the framework of an ecological risk assessment to examine common perceptions about the impacts of aquaculture on coastal and offshore habitats. The framework for this assessment was developed by the United Nations World Health Organization, has undergone extensive peer review, and is widely applied nationally and internationally. Ten types of potential impacts from aquaculture are noted: (1) increased organic loading from fecal material, uneaten food, and the decomposition of dead fish; (2) increased inorganic loading from fecal material and uneaten food; (3) residual heavy metals from uneaten food (primarily zinc) and from antifouling treatments (primarily copper); (4) transmission of disease to wild populations; (5) transmission of residual therapeutants to wild populations; (6) biological interactions from non-native species or genetically modified organisms with native populations from escapees, eggs, and gametes; (7) physical interactions with native populations through entanglement with nets, moorings, and other structures; (8) physical impacts on habitat from dredging, filling, nets, moorings, or other structures needed to establish a facility; (9) reductions in native populations from use of wild-caught juveniles for grow out; and (10) harvesting of industrial fisheries for use as fish feed. The assessment concludes that the level of risk from these sources is none to low when proper management measures are in place, including siting facilities to avoid areas with low water circulation or high boat traffic, judiciously managing stocking densities and managing waste, carefully selecting grow-out stock, and adhering to best management practices to control fouling, escapes, predation, diseases, and so forth. Use of geographic information systems (GIS) has led to spatial models that aid the examination of alternative sites for aquaculture operations (for an example from the southeastern U.S., see Arnold et al. 2000).

NOAA is building a broad based aquaculture program to enable expansion of all suitable forms of marine aquaculture within the context of complementing seafood production from wild catch, safeguarding environmental resources, and balancing multiple uses. An important objective of this program is to establish a comprehensive regulatory program for marine aquaculture operations. This program will complement existing regulatory programs that already apply to aquaculture operations, such as regulation the U.S. Army

Corps of Engineers and U.S. Coast Guard of the placement of structures within navigable waters, regulation of water quality by the U.S. Environmental Protection Agency and individual states, regulation of therapeutants by the Food and Drug Administration, and oversight of interactions with fisheries and endangered species by NOAA's National Marine Fisheries Service.

6.1.1.3 Silviculture

Forested wetlands are the most abundant wetland type along the eastern seaboard. They include such diverse types as black spruce bogs, cedar swamps, red maple swamps, and bottomland hardwood forests (Tiner 1984). Scrub/shrub and forested wetlands account for over 59.4 million acres within coastal counties from North Carolina to Florida (Field et al 1991). These wetlands also have been the most affected by forestry practices and, to a lesser degree, development. At a national level, from the mid 1950's to the mid 1970's, about 440,000 acres/year of palustrine wetlands (including forested wetlands) were lost (Tiner 1984). About 87 percent of this loss is accounted for by agricultural development; including silviculture (Tiner 1984). Trends in the Southeast follow the national trend with North Carolina and Florida registering the most extensive wetland losses (Tiner 1984).

Potential Threats to EFH from Silviculture

Potential threats include: conversion of wetlands to silviculture production sties or for tree removal and other silviculture related purposes such as roads and irrigation ponds; direct and/or non-point-source discharge of fill, nutrients, chemicals, and surface and ground waters into streams, rivers and estuaries; hydrological modification to include ditches, dikes, irrigation ponds and other similar structures and water control devices; damage to wetlands and submerged bottoms by timber harvest activities; connected actions such as the construction of roads, and cumulative and synergistic effects caused by association of these and other silviculture and non-silviculture related activities.

The southeastern United States produces more industrial timber than any other region of the world. This timber production is from a forest base that includes almost one-half of the world's industrial forest plantations (Lee et al. 2005). Silviculture presents a significant threat to EFH largely due to the concentration of this activity in landscape positions near certain EFH, especially anadromous fish spawning and nursery areas and brackish primary and secondary nursery areas. Although silviculture typically is a less intensive land use activity than agriculture or urban development (Hughes 1996), the periodic intense disturbances associated with harvest, the installation and maintenance of dense drainage systems in wetlands and former wetlands, changes in vegetation, and the use of nutrient supplements and toxicants can significantly and adversely affect surface waters, EFH, and their associated biota.

The most important fundamental change with installation of intensive silviculture, pertains to the water management system. Dense drainage systems allow the removal of significant amounts of water from hydric soil sites, intercept rain, and dewater stored groundwater. The effect on the wetlands can be serious if water tables are lowered such that hydric soils loose their water content. Organic constituents of hydric soils can then be oxidized, causing soil subsidence and liberation of previously bonded metals and nutrients. Clearing vegetation from wetland soils may also divert surface water into runoff pathways to the extent that both annual average runoff and event-related peak flows are exacerbated (Daniel 1981, McCarthy and Skaggs 1992). This runoff is a threat because it can change salinity regimes in receiving brackish water systems and it carries excess nutrients and other potential pollutants into sensitive waters and EFH (Pate and Jones 1980).

Conversion of mixed forested wetland and depressional cypress dome areas to silviculture is known to significantly reduce the water table. Studies have shown that slash pine (*Pinus elliottii*) through evapotransport can reduce the water table in an area by up to 36-inches depending on tree maturation. This reduction in subsurface water is higher than wetland canopy species that might have been originally found in a converted wetland area and contribute to soil subsidence and oxidation (value loss). Further this change in land-use (conversion of a wetland to silviculture) and the accompanying hydrological alterations change how these areas are regulated. In Florida, some silviculture areas are not regulated by state or federal agencies as wetlands even though many of the wetland characteristics are still evident (hydric soils, wetland vegetation, and hydroperiod). As a result conversion of these areas to commercial and residential development is expedited and little to compensatory mitigation for wetland function loss (albeit impaired or reduced) is not sought (Kruczynsky, personal communication).

The sensitivity of EFH to water balance perturbations is variable and poorly understood. Although some important species are highly sensitive to excessive salinity changes at young age classes (e.g., brown shrimp; Hunt et al 1980), relatively little is known about the overall implications of flow modification from drained silvicultural areas. Limited studies on pumped drainage water in North Carolina showed minor impact to juvenile and adult spot and Atlantic croaker in response to pumping (Broad Creek Study Report). Effects on spring post-larval settlement periods for brown shrimp remain speculative since the effects of rainfall during pumping have not been determined.

In the Altamaha drainage in Georgia, water balance disturbance is thought to be a key factor in declining catch per unit effort of blue crab and shrimp (J. Holland, personal communication) and an in-depth hydrological investigation of that area has been proposed. Livingston et al (1997) showed that reductions in freshwater inflow to the Appalachicola River Estuary in Florida led to initial turbidity reductions and increased primary productivity. Over time productivity reductions and major food web shifts were observed, probably in response to decreased nutrient delivery. As reported by Livingston et al (1997) food web shifts remained minor so long as river flow did not greatly exceed natural limits. There is a concern that southeastern watersheds would respond in a similar manner.

Silviculture also has the potential to significantly affect nutrient delivery patterns into EFH, both through soil amendments with nitrogen and phosphorus and through changes in nutrient processing and delivery systems. Modification of these delivery patterns can be a threat to EFH. Typical forestry operations in the southeast add limited nitrogen and phosphorus during the growing cycle (Amatya et al 1996). In addition, typical wetland soils are effective at removing incident nitrogen through nitrification and denitrification pathways. Wetlands are important sinks for atmospherically derived nitrogen. As such, riparian and isolated wetlands may buffer EFH from vehicle and animal waste-derived nitrogen enrichment. Drainage networks effectively short-circuit this buffering capacity by reducing retention periods and denitrification opportunities (Whigham et al 1988, EDF and WWF 1992).

The huge areas involved and their proximity to sensitive estuaries makes forestry a major player in nutrient enrichment. For instance, in North Carolina's Neuse River Estuary, forests account for 17 percent of total nitrogen delivery (NCDEHNR 1993). The adjacent Pamlico Basin reflects a forestry contribution for nitrogen of about 10 percent (NCDEHNR 1994).

Sediment yields from silviculture in the coastal zone are not considered a substantial threat to EFH. Sedimentation is typically lower than Piedmont or mountain sites as a result of lower terrestrial slopes and enhanced opportunity for deposition in the slower moving receiving waters, including canal systems.

Information is poor on forestry contributions to fecal coliform contamination in the Southeast. Initial studies have found relationships between elevated runoff rates after clear cutting and fecal coliform delivery, but other factors were also at work (J. Sauber personal communication).

Non-nutrient pollution from silviculture is also of concern, though poorly documented. A number of studies have shown release of mercury and other metals from peat soils subjected to intensive drainage (Evans et al 1984, Gregory et al 1984). Elevated mercury concentrations also have been found in organic sediments in riparian coastal watersheds (Otte et al 1987). In North Carolina, fish from the Waccamaw Basin show elevated mercury levels (NCDEHNR 1996b) and metal levels in sediments are elevated throughout the Albemarle-Pamlico Region due to a variety of sources (Riggs et al 1991). Although not directly related to silviculture, real estate ventures by timber companies have converted large areas of forest land to residential property. This has resulted in much faster rates of surface water runoff and discharge of waters that contain higher concentrations of pesticides and fertilizers. In coastal areas and in inland locations bordering rivers and streams, property values may be greatly increased and the conversion of forest land to residential and commercial property is proceeding at a rapid rate. Further, connected actions, such as the construction of access roads to silviculture sites increase the overall area of impact.

6.1.1.4 Urban/Suburban Development

The southeastern United States has undergone one of the highest rates of landscape changes in the country, in part due to changing demographics and land use practices over the last few decades (Milesi et al. 2003). In particular this trend has been observed in the coastal regions of the southeast. Nine of our nation’s ten largest cities are located in coastal watersheds (Bureau of the Census 2002). With its extensive and accessible coastline and mild winter climate the southeast coastal zone is one of the nation's fastest growing regions. The regional growth rate here is more than four times the national average (Chambers 1992) and between 1980 and 2010 the south Atlantic coastal population is expected to increase by as much as 73 percent (Chambers 1992). While coastal watershed counties comprise less than 25 percent of the land area in the United States, they are home to more than 52 percent of the total U.S. population. A study of coastal population trends predicts average increases of 3,600 people a day moving to coastal counties, reaching a total population of 165 million by 2015. These figures do not include the 180 million people who visit the coast every year (U.S. Commission on Ocean Policy 2004).

As the population increases so does urbanization. People require homes and related infrastructure such as roads, schools, water and sewer facilities, power transmission lines, etc. These needs often are met at the expense of EFH since residential growth has led to large scale modification of wetlands and other irreplaceable environments. Research indicates that nearby water bodies can become seriously degraded when more than 10 percent of the watershed id covered by roads, parking lots, roof tops, and similar surfaces (NRDC 1999). Tiner (1984) estimates that about 8 percent of the national rate of wetland losses that occurred from the mid 1950's to the mid 1970's resulted from urban development. Other effects of urbanization include increased sedimentation rates during and after construction, loss of surrounding upland recharge areas and wetland biofiltration and habitat functions. These effects could be ameliorated to some extent by maintaining sufficient buffers and less exploitive developmental patterns. The effect could be dampened by constructing within existing land contours and removing only the canopy necessary for project success. Currently in areas under development all existing vegetation is cleared and burned, all contours are removed and wetland soils are removed and replaced or filled over. Buffer ordinances, if they exist, are typically between 30 and 50 feet adjacent to estuarine systems; this width is not strongly supported by scientific literature.

Chemicals produced and used by people also find their way into the waters as point-source and non-point source runoff. Examples include oil from roads and parking lots, and pesticides, herbicides, and fertilizers from golf courses and residential lawns etc. This has reduced water quality in waters and wetlands adjacent to urban developments. As a result, the quality of EFH is often much reduced and thousands of acres of shellfish waters are closed. The South Carolina Department of Natural Resources' (SCDNR) Tidal Creek Project (TCP) provides insight into the effects of urbanization and suburban development on South Carolina tidal creeks (Holland et al 1996, 2004; Sanger et al, 199a,b). This study has implications for other states as well. The study examines developmental effects on salinity, dissolved oxygen (DO), and pollution in tidal creeks having trophic, shelter, and nursery functions required by commercially, recreationally, and ecologically important fish and invertebrates. The study reveals the complexity of the environmental and ecological factors involved and shows correlations between development; changes in tidal creek chemical, physical, and biological characteristics; and alteration of species distribution, composition, and abundance. In general, the physical-chemical characteristics of headwater creeks were significantly altered when the amount of impervious surface exceeded 10-20% and living resources were altered when the amount of impervious surface exceeded 20-30% cover.

The TCP identified salinity as a major factor in controlling the distribution and abundance of living marine resources (Holland et al 1996, 2004). In watersheds having the greatest areas of roofs, roads, and parking lots it was found that recruitment and colonization by benthic fauna in these areas was less predictable than in more stable environments. TCP confirms that suitable DO concentrations are essential for maintaining balanced indigenous populations of fish, shellfish, and other aquatic biota in tidal creeks and that pollution-related decreases in DO may pose the greatest threat to the environmental quality of estuaries (Holland et al 1996, 2004). With respect to contaminants, an examination of both metal and organic contaminants taken in connection with the TCP study indicate that metal contaminants were 2-10 times lower in forested watersheds compared to industrial/urban watersheds (Sanger et al, 1999a). Organic contaminants, such as PAHs, PCBs, and DDT were also much lower in forested creeks compared to the industrial/urban creeks.

In another study of at larger watershed scales (14-digit Hydrologic Unit Code), Van Dolah et al. (in press), noted significant correlations in the concentrations of inorganic and organic contaminants and fecal coliform bacteria concentrations with the amount of urban suburban development. The correlation between contaminant concentrations and urban/suburban land cover, was stronger in tidal creek habitats within these watershed, compared to data obtained from larger open water habitats within these watersheds. Additionally the percentage of sites within the watersheds having elevated contaminants and fecal coliform bacteria was much greater in watersheds having > 50% urban/suburban development compared with those watersheds having < 30% urban/suburban cover.

As the linkage between urban and suburban development and declining fish abundance and health or quality is reinforced, the implications of anticipated population growth in coastal areas become even greater. This situation is especially critical in the southeast where recreationally and commercially important species are almost totally dependent on estuaries for their survival and for about $5.5 billion in annual commercial fishery benefits (Chambers 1990).

<u>Potential Threats to EFH from Urban/Suburban Development</u>

Potential threats include 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; direct and/or nonpoint-source discharge of fill, nutrients, chemicals, cooling water, and surface waters into ground water, streams, rivers and estuaries; hydrological modification to include ditches, dikes, flood control and other similar structures; damage to wetlands and submerged bottoms; and 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. (Note: certain related activities such as navigation are discussed in later sections). Of major concern is the piecemeal elimination of wetlands by filling for houses, roads, septic tank systems, etc. Wetland filling can directly eliminate or diminish the functional value of EFH and associated areas and resources. While the total area of wetlands affected by development is unknown, the rate of conversion was once estimated at 8 percent of the national average loss of 458,000 acres or 36,640 acres per year (Tiner 1984). Requests to alter coastal areas remain high and between 1981 and 1996, for example, in the southeast the NMFS reviewed more than 23,871 proposals requesting to alter wetlands for housing, shoreline structures, docks, roadways, and other related activities. A survey of 5,622 of these proposals involved 19,729 acres of wetlands (see Tables 26, 27, 28, & 29). Between 1996 and 2006, NMFS reviewed an additional 1,962 applications to fill wetlands to construct housing and 1,886 applications for shoreline modifications. Note that the acreage cited would not include wetland impacts from nationwide permits, dock footprint, loss of bottom area under pilings, or a great percent of shoreline fortification that is designated as "*di minimus*" by the COE and typically can range one to three feet from an existing seawall or bulkhead.

Another major threat posed by urban and suburban development is that of non-point-source discharges of the chemicals used in day to day activities, in operating and maintaining homes, roads, vehicles, 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 southeastern fishery resources and their habitat. Results of various studies in the South Atlantic Bight indicate that chemical contaminants from industrial, urban/suburban, and agricultural sources may cause impacts in estuarine ecosystems. Highest contaminant concentrations and greatest impacts were observed in the headwaters of small tidal creeks, which are nursery grounds for fish, crustaceans and molluscs. Protection and management of nonpoint-source runoff loading into these watersheds is essential in protecting habitat quality (Scott et al 1997). In the long-term, impacts of chemical pollution (e.g., petroleum hydrocarbons, halogenated hydrocarbons, metals, etc.) are likely to adversely impact fish (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.

Results of the previously mentioned TCP investigation confirm that suitable DO concentrations are essential for maintaining balanced indigenous populations of fish, shellfish, and other aquatic biota in tidal creeks and that pollution related decreases in DO may pose the greatest threat to the environmental quality of estuaries." The study found that:

- DO in tidal creeks fluctuated with phases of the moon, time of day, and tidal stage.
- DO in tidal creeks in developed and undeveloped watersheds often did not meet the state water quality standard of 4mg/L.
- The most stressful DO levels occurred during early morning and at night-time low tides.

- The DO levels in tidal creeks in developed watersheds were less predictable and had greater unexplained variance than those of undeveloped watersheds.
- Point in time DO measurements in tidal creeks do not adequately represent exposure of living resources stressful low DO levels.
- Living resources in tidal creeks in developed watersheds were more frequently exposed to stressful low DO levels than those inhabiting tidal creeks with undeveloped watersheds.
- The factors that contribute to low DO in South Carolina tidal creeks need further study and a DO budget for tidal creeks and associated saltmarshes is needed so that the major factors controlling low DO conditions can be identified and addressed from a management perspective.

With respect to contaminants, bioassays of sediments taken in connection with the TCP study indicate that potentially toxic conditions for living marine resources may occur in the upper reaches of tidal creeks in developed watersheds. Polyaromatic hydrocarbons in sediments were highest where surface runoff from roads was discharged into tidal creeks and sediment bound pesticides were more prevalent in the marsh and near houses. (Preceding is a summary taken from Holland et al 1996).

Finally with regard to urban/suburban development, and in particular regard to nonpoint-source discharges, the South Carolina Statewide Water Quality Assessment for FY 1992-1993 (SCDHEC 1994) provides an indication of the role of non-point source discharges in one southeastern state. According to the Assessment:

- Nonpoint-source (NPS) pollution is the most responsible factor for nonsupport of classified water uses in rivers, lakes, and estuaries in the state.
- Of the 26,313 river miles assessed via water quality monitoring stations, 10,534 miles, or 40%, were determined to be partially supporting or not supporting overall use. NPS sources of pollution were identified as the contributing factor 33% of the time. These NPS sources included agriculture, pasture land, silviculture, construction, urban runoff/storm sewers, resource extraction, and hydromodification.
- South Carolina has approximately 945 square miles of estuaries, including marshes. The assessment analyzed data collected from 342 square miles of estuaries. About 30% of the estuarine areas do not fully support overall use. NPS pollution sources were identified as the contributing factor 38% of the time.
- Of the 135 shellfish areas assessed, 63% were impacted by NPS, including marinas, 22% were impacted by point sources, and 27% were unconditionally approved (the percentages totaled exceed 100% due to multiple source impacts).
- The South Carolina NPS Task Force listed the 32 highest priority water bodies/watersheds that are targeted for implementation action. Of these water bodies/watersheds, 15 are located in the coastal zone.
- Sixty-two watershed units are located in the coastal zone. Based on information from the Statewide Assessment and from more recent Watershed Water Quality Management Strategies, 44% of these units have been impaired by NPS pollution; 39% have been impaired by unknown sources of pollution; 24% have been

impaired by point sources; 16% have been impaired by natural or other sources; and 30% have no known impairment [The percentages totaled exceed 100% due to multiple source impacts. Also, based on the Statewide Assessment, 38 of the 62 watershed units (or 61%) have not been fully assessed].

Point source discharges related to urbanization derive mainly from municipal sewage treatment facilities or storm water discharges that are controlled through Environmental Protection Agency (EPA)-mandated regulations under the Clean Water Act and by state water quality regulations. Threats related to these discharges are probably less important than the other factors previously discussed because efforts are underway to improve treatment. The primary concerns with municipal point-source discharges involve treatment levels needed to attain acceptable nutrient inputs and overloading of treatment systems due to rapid development of the coastal zone. It is also important to consider that the portion of water entering estuaries from sewage treatment plants is increasing. In locations where treatment is poor, or water conditions are unsuitable for adequate dilution of discharges, EFH may be adversely affected. Of primary concern is excessive nutrification of receiving waters, but other factors such as those associated with nonpoint -source discharges also apply.

The EPA withdrew the storm water Phase II direct final rule published on April 7, 1995 (60 FR 17950) and promulgated a new final rule in its place (60 FR 17958). This action by the EPA instituted changes to the National Pollutant Discharge Elimination System (NPDES) stormwater permit application regulations under the Clean Water Act for Phase II dischargers. Phase II dischargers generally include all point-source discharges of storm water from commercial, retail, light industrial and institutional facilities and from municipal separate storm sewer systems serving populations of less than 100,000. This rule establishes a sequential application process in two tiers for all Phase II stormwater discharges. The first tier provides the NPDES permitting authority flexibility to require permits for those Phase II dischargers that are determined to be contributing to a water quality impairment or are a significant contributor of pollutants to waters of the U.S. “Permitting authority” refers to the EPA or States and Indian Tribes with approved NPDES programs. The EPA expects this group to be small because most of these types of dischargers have already been included under Phase I of the storm water program.
The second tier includes all other Phase II dischargers. This larger group will be required to apply for permits by the end of six years, but only if the Phase II regulatory program in place at that time requires permits. The EPA has stated that it is open to, and committed to, exploring a number of non-permit control strategies for the Phase II program that will allow efficient and effective targeting of real environmental problems. As part of this commitment, the EPA has initiated a process to include stakeholders in the development of a supplemental Phase II rule under the Federal Advisory Committee Act. This rule will be finalized by March 1, 1999 and will determine the nature and extent of requirements, if any, that will apply to the various types of Phase II facilities prior to the end of the six-year application period defined by the rule.

However, in practice, the EPA’s NPDES for Phase II dischargers program, can be slow to implementation and has limited enforcement authority. Further, stormwater requirements in the State of Florida have resulted in the loss/conversion of wetlands as required treatment ponds are commonly placed in wetlands whose capacity to assimilate contaminates far exceeds any benefit provided by the area loss for stormwater abatement. Further conversion of wetlands to stormwater ponds permanently eliminates these areas ability to contribute dissolve and particulate detrital organic carbon and their ecological habitat functions. These conversions are not seen or recorded as wetland losses although the lost ecologically contribution of these areas has an enormous impact on fisheries.

6.1.1.5 Transportation

Transportation projects such as the construction and maintenance of bridges and roadways typically involve long-term planning and permit consultation with NMFS. Such projects can occur over estuarine waters, within estuarine emergent wetlands, and/or other important wetlands that are hydrologically connected to tidal waters. Between 1996 to present NMFS reviewed 2,352 actions related to transportation.

<u>Potential threats to EFH from transportation projects</u>
Potential threats include fragmentation of the ecosystem by isolation and bifurcation of EFH, storm water discharges and runoff, shading of submerged aquatic vegetation from bridges, and blasting associated with bridge or structure demolition.

Transportation project can lead to habitat fragmentation, which results in the isolation of EFH from certain life history stages of recreationally and commercially important fisheries. This isolation limits the food chain by not allowing certain assemblages of organisms to easily traverse from one ecotype to another. This is especially true for fisheries such as snapper grouper complex that use mangroves swamps and seagrass beds for one or more of life history stages. This fragmentation could also potentially limit movements of catadromous and anadromous fishes by isolating populations from a spawning or nursery ground. Fragmentation can also result in the isolation of large tracts of freshwater wetlands. Through this isolation, the trophic functions provided by these wetlands are limited and allochthonous input is cut off to downstream estuaries and EFH.

Flushing of upstream wetlands and EFH can be impacted by fragmentation. If mitigation measures (e.g., culverts and bridges) are not taken to maintain adequate flow on both sides of a roadway, waters can become stagnant and limit the benefits to commercial and recreational fisheries.

Storm water discharges are a concern where bridges or roadways cross or are adjacent to EFH. Runoff from roadways could impact EFH if water is not collected and treated prior to discharge. The treatment of the storm water, including surface water management systems, should be located outside of EFH.

Blasting and demolition pose threats to EFH and managed fisheries. Direct and indirect impacts to EFH should be avoided and best management practices utilized when demolition occurs. This can include detonating small charges (otherwise known as test blasts or fish scares) to direct fish away from the area where the demolition will take place. Bubble curtains are also used in some cases to minimize fish kills.

Direct and indirect affects to EFH can also result from construction. Submerged aquatic vegetation can be impacted directly or indirectly from the installation of pilings and shading associated with bridges. The areas adjacent to bridges can be impacted as well from the shadow cast from the structure. These impacts must be considered when evaluating the effects of a transportation project on EFH.

6.1.1.6 Industrial/Commercial Activities

The southeastern U.S. is a prime location for industrial siting. The climate is favorable, economic incentives exist, land is readily available and relatively inexpensive, an adequate labor base exists, and the infrastructure for shipping of supplies and products is well developed. Further, the region's many rivers and streams provide an abundance of water needed for textile mills, paper mills, and heavy manufacturing (e.g., steel fabricating) and other similar facilities.

In addition to a favorable setting for industrial development, commercial growth is ever expanding. Although less conspicuous in many areas, the tourism industry also is a vital part of the coastal economy and many of the South's most popular vacation spots are located on or near the coast. With expansion of this industry, new hotels, related businesses, marinas, roads, and other facilities are being built. The increase in visitors and resource users is expected to continually grow and may diminish only when, as a result of over use and development, the environmental quality of the area is reduced. Population growth and tourism bring many benefits to coastal communities, including new jobs and businesses and enhanced educational opportunities. Burgeoning industries associated with tourism and recreation in coastal areas (such as hotels, resorts, restaurants, fishing and dive stores, vacation housing, marinas, and other retail businesses) have created one of the nation's largest and fastest-growing economic forces (U.S. Commission on Ocean Policy 2004). In just four South Florida coastal counties, recreational diving, fishing, and ocean-watching activities generate $4.4 billion in local sales and almost $2 billion in local income annually (Johns 2001) and more than 2.9 million people visit the Florida Keys each year (Leeworthy and Vanasse 1999).

<u>Potential Threats to EFH from Industrial/Commercial Activities</u>
Potential threats include conversion of wetlands to industrial and appurtenant sites such as roads, parking, and administrative and distribution centers; point and nonpoint-source discharge of fill, nutrients, chemicals, cooling water, air emissions, and surface and ground waters into streams, rivers, estuaries and ocean waters; hydrological modification to include ditches, dikes, water and waste lagoons; intake and discharge systems; hydropower facilities; and cumulative and synergistic effects caused by association of these and other industrial and non-industrial related activities. In addition to ongoing activities, previous industrial and commercial activities have, in many locations, led to deposition of harmful materials that are subject to resuspension and reincorporation into aquatic food chains.

Industrial and commercial development can affect EFH in a number of ways. Most apparent is the conversion of wetlands and upland buffers to sites for buildings, plants, parking, storage and shipping or materials and products, and treatment or storage of wastes or by-products. Because of an abundance of hard impervious surfaces associated with industrial and commercial operations they are often major contributors of non-point-source contaminants into aquatic environments, including those that support EFH. Many industries e.g., paper mills, consume and pollute large volumes of water needed to sustain a healthy coastal environment. Industries may also produce airborne emissions that contain contaminants. These contaminants have been shown to reappear in coastal waters and EFH. A readily observable example is acidification of waters from atmospheric deposition of industrial emissions and coal fired power plants. Commercial development along the south Atlantic coast also has been extensive and relatively few coastal areas are free of commercial development. Past development practices were especially detrimental and before adequate regulation it was not uncommon to excavate and fill marshes and shallow water environments for residential, commercial and industrial uses. Such practices have been largely eliminated because most of the coast is either developed or protected from such practices. However, uplands are a decreasing commodity in the coastal zone and the demand for filling wetlands and other aquatic sites is likely to persist. Consequently, proposals aimed at altering wetlands for commercial and other purposes will continue to require local, state, and federal involvement if significant adverse impacts to EFH are to be effectively controlled.

The total amount of EFH that has been eliminated or degraded by commercial and industrial development is unknown, but it is extensive. NMFS data show that between 1981 and 1996, 1,466 proposals were received for industrial and commercial development in wetlands that are subject to regulatory provisions the River and Harbor Act and Section 404 of the Clean Water Act. In association with this, 430 proposals sought approval to alter about 3,202 acres of EFH (see Tables 26, 27, 28, & 29). Between 1996 and 2006, NMFS reviewed approximately 2,126 applications for industrial and commercial activities and associated wetland impacts in the South Atlantic area. Point-source discharges from commercial activities may be similar to those associated with urban and suburban development. Accordingly, the information and discussions contained in Section 4.1.1.3 should apply. Pollution and water use may alter the flow, pH, hardness, dissolved oxygen, and chemical composition other parameters that affect individuals, populations, and communities (Carins 1980). Within aquatic systems industrial point-source discharges also may alter species and population diversity, nutrient and energy transfer, productivity, biomass, density, stability, connectivity, and species richness and evenness both at the point of discharge and downstream locations (Carins 1980). Growth, visual acuity, swimming speed, equilibrium, feeding rate, response stimuli, predation rate, photosynthetic rate, spawning seasons, migration routes, and resistance to disease and parasites of finfish, shellfish, and related organisms may be altered by chemical and thermal changes. Some industries, such as paper mills, are major water users and associated effluent can dominate and control conditions in substantial portions of rivers and other water bodies where they are located. Usually parameters such as substrate, currents, dissolved oxygen, pH, nutrients, temperature, and suspended materials are key factors affecting the distribution and abundance of EFH. The direct and synergistic effects of other discharge components such as heavy metals and various chemical compounds are not well understood, but current research shows that these constituents may be of greater importance than previously thought. For example, more subtle factors such as endocrine disruption in aquatic organisms and reduced ability to reproduce or compete for food are being uncovered (Scott et al 1997).

The cumulative effect of many types of discharges on various aquatic systems also is not well understood, but attempts to mediate their effects are reflected in various water quality standards and programs in each state and within the various water systems. Industrial wastewater effluent is regulated by the EPA through the NPDES permitting program. This program provides for issuance of waste discharge permits as a means of identifying, defining, and controlling virtually all point-source discharges. The complexity and the magnitude of effort required to administer the NPDES permit program limit overview of the program and federal agencies. Consequently, the NMFS and the FWS generally do not provide comments on NPDES application notices. For these same reasons, it is not presently possible to estimate the singular, combined, and synergistic effects of industrial (and domestic) discharges on aquatic ecosystems. Where chronic non-point-source discharges and accidental releases of harmful or toxic substances mix, especially harmful effects on aquatic life and habitat, including EFH, is likely. An added concern with industrial operations is the release of contaminants into the atmosphere. Such materials may be transported various distances and directly and indirectly deposited into aquatic ecosystems (Baker et al 1993). In the southeast, surface water acidification and mercury accumulation in sediments are of particular concern since sources of these material lie in other regions and are not subject to local and regional (southeastern) controls. In view of this, the regulation of surface water contamination from atmospheric pollution should be addressed from a local, regional, and international perspective.

6.1.1.7 Navigation

Support for navigation in the southeast Atlantic region has resulted in widespread modification of subtidal and intertidal areas used by commercial and recreational vessels. Significant modification to offshore habitats has also occurred and this is discussed in the Offshore Threats Section. Primary threats to EFH from navigation in estuarine waters include the construction, maintenance, and expansion of thousands of miles of waterways such as the Atlantic Intracoastal Waterway and the myriad of other channels that lead to marinas, ports, turning basins, and harbors. Construction and maintenance of existing ports and recreationally-based marinas and basins have altered substantial areas of EFH. Expansion of existing channels and waterways to accommodate larger vessels, primarily mega-yachts and Post-Panamax vessels, is becoming an increasing threat to inshore EFH, namely seagrasses. Dredged material disposal and disposal of contaminated sediments is also an issue. Filling of wetlands and conversion of EFH from shallow to deep water habitats are persistent threats associated with new facilities and the maintenance and expansion of existing facilities. Where coastal inlets are stabilized and maintained for navigation purposes effects on nearshore environments and fish and invertebrate populations may be substantial in addition to blockages of littoral sediment transport.

A second major concern related to navigation is the host of environmental problems associated with vessel operations. These range from contamination of water by oil, grease, anti-fouling paints, and discharges of sewage, garbage, and debris to the direct destruction of EFH by grounding, anchor damage, propwashing, scarring, etc. Most physical damage is accidental; however, activities such as propwashing could be avoidable for example, through better sinage in waterways near shallow SAV habitats and a greater of level of enforcement. However, regarding the latter, it should be recognized that many State and local enforcement programs are severely understaffed and underfunded.

Potential Threats to EFH from Navigation

Navigation related threats to EFH located within estuarine waters can be separated into two categories: Navigation support activities and vessel operations. 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 operations activities include, but are not limited to: discharge or spillage of fuel, oil, grease, paints, solvents, trash, and cargo; grounding/sinking/prop scaring in ecologically/environmentally sensitive locations; exacerbation of shoreline erosion due to wakes; salt water intrusion into brackish systems; and transfer and introduction of exotic and harmful organisms through ballast water discharge.

Navigation Support Activities

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 and maintenance dredging is unknown, but undoubtedly great. Orlando et al (1988) analyzed 18 major east coast estuaries from North Carolina to Florida east coast and found over 703 miles of navigation channels and 9,844 miles of shoreline modifications related to navigation works. Between 1981 and 1986 the NMFS received over 4,877 proposals for new navigation projects in the south Atlantic region. A detailed analysis showed that 1,692 of these proposals involved plans to alter 24,825 acres of EFH through dredging and filling (Tables 26, 27, 28, & 29). Between 1996-2006, NMFS received 1,055 applications for maintenance dredging related activities and 720 application-related to construction of marinas and navigation channels in the South Atlantic area.

However, the potential threats to EFH from widening and deepening navigation channels warrant close examination. In many south Atlantic areas, marina owners and inland navigation districts have submitted applications to the Corps of Engineers for widening and deepening activities to accommodate mega-yachts and provide navigation access for mega-yacht vessels to private interior berthing, testing, and repair facilities located in the vicinity of inlets. Mega-yachts are typically classified as private luxury recreational motor or sailing vessels that are greater than 80 feet in length and there are approximately 735 that would access south Atlantic navigation channels (FWS 2005). In Palm Beach County, Florida alone proposed impacts associated with Atlantic Intracoastal Waterway and other channel expansion projects exceed 30 acres of seagrass habitat within Lake Worth Lagoon and typically involve dredging deeper than the Water Resources

Development Act Congressionally authorized depths, for example from -10 NGVD to -16 NGVD. The seagrass habitats located around inlets are typically unique and ecologically significant due to the influence of clear oceanic waters that enter through the inlet and provide water clarity that cannot be found in locations further from the inlet. For example, the seagrass habitat located in close proximity to the Lake Worth Inlet (Florida) allows seagrass to grow at depths of over 10 feet as opposed to more remote seagrass habitat, which may only reach depths of 4 feet.

According to a FWS report, the overriding factor in the decline of estuarine and marine wetlands in the U.S. between 1998 and 2004 was the loss of emergent saltmarsh to open saltwater systems due to and manmade activities such as dredging, water control, and commercial and recreational boat traffic (Dahl 2006). While channel excavation itself is usually visible only from the surface while the dredge or other equipment are 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 impacts 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 of nutrients, metals, and organics; release of oxygen consuming substances; noise disturbance to aquatic and terrestrial organisms; and alteration of hydrodynamic regimes and physical habitat.

The maintenance and stabilization of coastal inlets also is a prominent navigation activity. Studies and reports by the COE, the NMFS, and others link jetty construction to possible changes in plankton movement (USACE 1980, USDC 1991, Miller 1988, Miller et al. 1984). This is a major concern since significant modification of inlet hydrodynamics may diminish the ability of sub-adult fish and invertebrates to reach estuarine nursery grounds. Where significant reductions in recruitment (into estuarine waters) of desirable species is realized, production declines in ecologically, recreationally and commercially important species may result. The use of jetties to stabilize navigation channels at coastal inlets also has been linked to changes in coastal geomorphology that affects nearshore environments. For example, coastal geologists have expressed concern that construction of jetties at Oregon Inlet on the North Carolina Outer Banks could cause catastrophic beach erosion and accelerate barrier island migration (Pilkey and Dixon 1996). Such change could adversely affect the extensive and highly productive submerged vegetation beds which are located behind the coastal barriers.

The relocation of freshwater/saltwater transition zones due to channel deepening may be, in some cases, responsible for significant environmental and ecological change. As an example, salinity shifts after channel deepening and water diversion in the lower Savannah River caused vegetation shifts from freshwater to brackish species in surrounding wetlands. In the lower Savannah River, increased mortality of sub-adult striped bass also has been linked to salinity increases caused by navigation-related modifications such as channel deepening and flow diversion. Modifications that increase estuarine salinities may also create more hospitable conditions for shellfish predators such as boring sponge, oyster drill, and keyhole limpet.

In south Florida, increased channelization by dredging and the addition of rocky structures may have favored shifts from estuarine assemblages to reef assemblages because of comparatively higher abundances and diversities of incoming ichthyoplankton, higher inshore salinities, and replacement of vegetation with hard structure that favors reef species (Lindeman 1997). Similar situations are possible in other watersheds where dredging and dredged material disposal are prominent features; however, little documentation of these changes is available. Another example includes the St Johns River in North Florida. The St Johns River’s watershed encompasses 50 percent or more of the east coast of Florida flowing North and in the 1800’s flowed out onto an alluvial flood plan of shallow non-navigable sand bars. Construction of the Jacksonville Port has deepened and channelized the river mouth, now -52 NGVD. As a result, the amount of salt water intrusion has completely altered the estuarine system of the lower St Johns River.

The expansion ports and marinas has become an almost continuous process due to economic growth, competition between ports, and significant increases in vessel numbers and vessel size. Elimination or degradation of aquatic and upland habitats are commonplace since port and marina expansion almost always require 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. Modern pollution containment and abatement systems and procedures can prevent or minimize toxic substance releases; however, constant and diligent pollution control efforts must be implemented. 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 flushing characteristics, facility size, location, depth, and configuration. When facilities such as marinas are constructed it is common to restrict shellfish harvest in a set or established zone that may be affected by sewage and other hazardous materials. It is now common practice to consider safe zones with respect to public health and aquatic resources when siting marina and port facilities. Major ports in the south Atlantic region include Morehead City and Wilmington in North Carolina; Georgetown, Charleston, and Port Royal in South Carolina; Savannah and Brunswick in Georgia; and Fernandina Beach, Jacksonville, Port Canaveral, Port Everglades, Port St. Joe, Fort Pierce, Palm Beach, and Miami in Florida. Many eastern seaboard ports are subject to proposals to widen and deepen to accommodate Post-Panamax vessels or deep-draft vessels too large to fit through the Panama Canal. Impacts resulting from these projects can be substantial and can involve alternatives to dredge through coral reef, hardbottom habitat, and seagrasses.

In 2005, the Port of Miami, located in Biscayne Bay which is a State of Florida designated Outstanding Florida Water, completed a harbor deepening project that used confined blasting to fracture rock that was too hard to be removed via conventional dredge. In 2004 the Corps of Engineers finalized an Environmental Impact Statement to widen and deepen the entrance channel and other interior areas of the Port to -50 NGVD. The Recommended Plan would impact approximately 415 acres of habitat including over 6.3 acres of seagrass habitat, 28.7 acres of low-relief hardbottom/reef habitat, 20.7 acres of high relief hardbottom/reef habitat, 123.5 acres of rock/rubble habitat, and 236.4 acres of unvegetated bottom habitat (COE, 2003).

The COE recently finalized a Reef Report for Port Everglades Outer Entrance Channel Expansion Project that concluded that over 150,000 corals and 21 acres of reef could be lost through proposed expansion activities (COE 2006). This project is in the feasibility phase and the COE proposes to release the draft Environmental Impact Statement in October 2007. In addition to the reef impacts, this project could impact up to 5 acres of seagrass (including one acres of the federally listed *Halophila johnsonii*), 11.55 acres of mangroves (8.48 acres of which are currently held in a conservation easement for impacts from previous Port activities), and 20.09 acres of previously dredged hardbottom, for which no compensatory mitigation is currently proposed (FWS 2005).

Cargo arriving and departing through these ports is diverse and ranges from highly toxic and hazardous chemicals and petroleum products to relatively benign materials such as wood chips. Major spills and other discharges of hazardous materials are uncommon, but are of constant concern since large and significant areas of estuarine habitat and fishery resources are at risk. Expansion of these facilities and certain operation and maintenance activities are likely to occur at the expense of EFH.

There have been recent positive trends in the development of beneficial uses for clean dredged materials. For example, the deepening of the Wilmington Harbor navigation channel in North Carolina generated rock that is being used for creation of an offshore reef. Similar activities are being investigated in connection with planned deepening of Charleston Harbor in South Carolina. These activities will require monitoring to evaluate their success, but if beneficial other uses of dredged material could be developed. On a cautionary note, conversion of one habitat type to another may not be desirable since associated ecological trade-offs could be harmful to desirable or managed species. The classic example of this is the Winyah Bay, South Carolina dredged material disposal site, where submerged and intertidal bottoms have been converted to emergent marsh without any assessment of the ecological role of the disposal site.

Dredging and disposal of excavated materials is a major component of all southeastern ports and many marinas. Dredged materials are often contaminated and extensive testing for heavy metals and other contaminants is required. At many locations finding suitable disposal sites for dredged materials is also difficult and costly. Whenever contaminated dredged materials are placed in offshore waters, or in locations where decant is discharged into surrounding waters there is high probability that these contaminants will reenter aquatic food webs. As existing upland disposal sites are filled this problem is likely to be exacerbated. Already, direct overboard dispersal of dredged material occurs at some location such as in reaches of the Atlantic Intracoastal Waterway in North Carolina. In other locations such as the Savannah River, Georgia, a technique referred to as “agitation dredging” is used. In this case, about 200,000 cubic yards of materials are resuspended from ship berths each year by bottom dragging or by hydraulic excavation with direct disposal into the adjacent navigation channel. In addition, hydraulic bottom scour systems are presently in place in Wilmington, North Carolina, and experimental use of these devices is planned at one facility in Savannah and at the U.S. Navy’s Kings Bay, Georgia, Submarine Base. The environmental impact associated with the use of this technique is unclear, but significant use of bottom scouring devices could be problematic since planktonic and weak swimming fish and invertebrates could be impinged or entrained in intakes and plumbing, and turbidity and sedimentation could be exacerbated. Of particular concern is those aquatic environments that contain anadromous fish since planktonic and weak swimming fish could be heavily impacted.

An additional, but more limited dredging practice is the prop dredging of bottoms, mostly by recreational vessels, to obtain navigable depths. This practice is generally performed without benefit of state or federal permits and is almost always destructive.
The SAFMC is opposed to open water disposal of dredged material into aquatic systems when adverse impacts to habitat used by fisheries under its jurisdiction are likely. The SAFMC urges state and federal agencies, when reviewing permits considering open water disposal, to identify the direct and indirect impacts such projects could have on fisheries habitat. It is also their view that the conversion of one naturally functioning aquatic system at the expense of creating another (marsh creation through open water disposal) must be justified using the best available information.

Construction of piers and docks also affects EFH, but the degree of the impact is often disputed. Impacts are dependent on the size, location, and number of similar structures in a given area. Pier and dock construction involves often involves jetting of pilings and this causes temporary and localized affects on EFH due to increased sedimentation and habitat displacement. Sedimentation may be a problem in systems such as SAV that are already stressed and are declining or marginal value due to low water clarity. The pilings are treated and toxic chemicals are released into the waters and sediments, but this is not perceived to be a major problem since the pilings are eventually covered with encrusting and fouling organisms. Perhaps the greatest threats from piers and docks are those associated with marsh and SAV shading and the erosion, due to wave action, of substrates in the vicinity of support piles. Substantial harm to SAV and benthic communities may also result from secondary effects associated with boat use, including constant grounding due to wave and tidal action.

The overall biological effects of piers and docks has not been well quantified. However, between 1981 and 1996, the NMFS reviewed requests for almost 6,000 piers and docks along the southeast coast between North Carolina and Florida. Between 1996 and 2006, NMFS reviewed an additional 7,540 applications to construct docks and pilings. In areas having marginal depths and especially where SAV is present, habitat damage in the vicinity of piers and docks may be substantial and disproportionately large in cases where such structures are abundant (Ludwig et al 1997). These structures represent a substantial feature in southeastern watersheds and they warrant continued monitoring and regulatory review. In response to this, NMFS and U.S. Army Corps of Engineers Jacksonville

District jointly developed *Dock Construction Guidelines in Florida for Docks or Other Minor Structures Constructed in or over Submerged Aquatic Vegetation, Marsh or Mangrove Habitat* in addition to the *Key for Construction Conditions for Docks or Other Minor Structures Constructed in or over Johnson's seagrass (Halophila johnsonii)* (see http://www.saj.usace.army.mil/permit/hot_topics/Dock_Guidelines/dockindex.htm). In general, these guidelines provide environmentally responsible access to Florida waters.

Vessel Operations

In connection with watercraft operation and support the USEPA (1993) has identified several principal concerns. These include pollutants discharged from boats; pollutants generated from boat maintenance activities; exacerbation of existing poor water quality conditions; pollutants transported in storm water runoff from parking lots, roofs, and other impervious surfaces; and the physical alteration or destruction of wetlands and of shellfish and other bottom communities during the construction of marinas, ramps, and related facilities.

Marinas and other sites where vessels are moored or operate often are plagued by accumulation of anti-fouling paints in bottom sediments, by fuel spillage, and overboard disposal of trash and wastewater. In areas where vessels are dispersed and dilution factors are adequate, the water quality impacts of vessel operations are likely to be offset to some degree. In a study of marinas in North Carolina it was found that marinas may contribute to increases in fecal coliforms, sediment oxygen demand, and chlorophyll a, and decreases in dissolved oxygen (NCDEHNR 1990). In addition, boating and other activities (e.g., fish waste disposal) may contribute to increased water temperature, bioaccumulation of pollutants by organisms, water contamination, sediment contamination, resuspension of sediments, loss of SAV and estuarine vegetation, changes in sediment composition loss of benthic organisms, changes in circulation patterns, shoaling, and shoreline erosion. Pollutants associated with marinas include nutrients, metals, petroleum hydrocarbons, pathogens, and polychlorinated biphenyls (USEPA 1993).

Marina personnel and boat owners use a variety of boat cleaners, such as teak cleaners, fiberglass polish, and detergents and cleaning boats over the water, or on adjacent upland, creates a high probability that some cleaners and other chemicals will enter the water (USEPA 1993). Copper-based antifouling paint is released into marina waters when boat bottoms are cleaned in the water (USEPA 1993). Tributyl-tin, which is a major environmental hazard, has been largely banned except for use on military vessels. Fuel and oil are often released into waters during fueling operations and through bilge pumping. Oil and grease are commonly found in bilge water, especially in vessels with inboard engines, and these products may be discharged during vessel pump out (USEPA 1993).

Sewage and other wastes discharged from recreational boats may be most problematic in marinas and anchorage sites where vessels are concentrated. Despite existing federal and state regulations involving discharges of sewage and other materials, detection and control of these activities are difficult and discharges still occur. According to the 1989

American Red Cross Boating Survey, there were about 19 million recreational boats in the U.S. (USEPA 1993). About 95 percent of these boats were less than 26 feet in length and a large number of these boats used a portable toilet, rather than a larger holding tank. Given the large percentage of smaller boats, facilities for the dumping of portable toilet waste should be provided at marinas that service significant numbers of boats under 26 feet in length (USEPA 1993).

Increased recreational boating activity may contribute significantly to pollution of southeastern coastal waters by petroleum products. All two-cycle outboard engines require that oil be mixed with gasoline, either directly in the tank or by injection. That portion of the oil that does not burn is then ejected, along with other exhaust products, into the water. In 1990, 52,030 boats were registered in coastal North Carolina (North Carolina Wildlife Resources Commission, personal communication). Based on this number, conservative estimates indicate that about 84,549 gallons per year of oil (in fuel) is discharged annually into North Carolina's coastal waters (Hoss and Engel 1996). For comparison purposes, hydrocarbon discharges for coastal North Carolina in 1982, from boating and urban runoff are about 470 and 2,270 tons, respectively. Increased use of personal water craft such as jet skis has added to the volume of hydrocarbon being introduced into southeastern waters since the engine exhaust from these vessels is discharged directly into the propellant water jet. Similar problems are inferred for other states and areas having high concentrations of boats.

The chronic effects of vessel grounding, prop and jet ski 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 occur in all areas where vessels ply shallow waters. In addition, direct damage to multiple life stages of associated organisms, including egg, larvae, juveniles, and through water column de-stratification (temperature and density), resuspending sediments, and increasing turbidity (Stolpe 1997, Goldsborough 1997) have been observed in connection with vessel operation. This damage is particularly troublesome in North Carolina and Florida, the two South Atlantic states with submerged rooted vegetation in their coastal waters. In North Carolina, no official quantitative estimate of SAV damage has been performed; however, preliminary observations indicate that damage to the state's 135,000 acres of SAV is localized around marinas or other boat access points (R.L. Ferguson personal communication). Scarring estimates for Florida indicate that about 173,000 of the state's 2.7 million acres of SAV are scarred (Sargent et al 1995). On the Atlantic coast of Florida there are about 69,360 acres of SAV and 3,770 acres (18 percent) have been scarred by prop and other water craft action.

The ever increasing number of registered power boats along the south Atlantic coastal zone, and those temporarily entering coastal areas through tourism ensure that this threat is likely increase over time. Power boat registrations on Florida's east coast, not including sailboats, totaled 108,048 vessels in 1992-93. Of these, 95 percent were pleasure craft (Sargent et al. 1995).

The rapid increase in popularity of jet skis or “personal water craft” is also problematic. While these vessels are not propeller driven, the water jet removes sediment from seagrass roots and rhizomes and can cause damage. Further, these craft can operate in shallower waters and can access seagrass areas with relative ease, in addition to direct impacts to grassbeds. These machines are exceedingly loud and can create large wakes. It is reasonable to hypothesize that the audio and physical environment of shallow nursery areas may be disrupted in manners which stress postlarval life stages. The degree of stress is currently uninvestigated.

Incidences of commercial groundings are few, but where they occur on hard bottom habitats damage may be extensive and long-term. For example, groundings in the Florida Keys National Marine Sanctuary have caused extensive damage to coral reefs and signs of recovery are slow to appear.

The cumulative effect of anchor scarring in seagrass beds is not as damaging as that caused by propeller and jet powered vessels. On coral reefs, however, damage caused by anchoring of recreational boats is significant (Davis, 1977). Dragging or pulling anchors through coral beds breaks and crushes the coral, destroying the coral formation. Most reef damage of this type occurs in the Florida Keys and in nearshore waters.
The effects of vessel induced wave damage have not been quantified, but may be extensive. The most damaging aspect relates to the erosion of intertidal and SAV wetlands located adjacent to marinas, navigation channels, and boating access points such as docks, piers, and boat ramps. Wake related erosion in places along the Atlantic Intracoastal Waterway and elsewhere is readily observable and has undoubtedly converted substantial area of emergent wetlands to less important habitat such as submerged bottom. In heavily trafficked areas bottoms may become unstable and colonization by bottom dwelling organisms may not be possible. Indirect effects may include the resuspension of sediments and contaminants that can affect EFH. Where sediments flow back into existing channels, the need for maintenance dredging, with its attendant impacts, may increase.

The introduction of exotic species by vessel operations is linked largely to the world wide movement of commercial vessels. Exotic species may be brought into the U.S. by several methods, but capture and release in ballast waters is of most concern. With the introduction of the zebra mussel into the Great Lakes and its rapid dispersal into other waters, considerable attention is being directed at this problem. According to one estimate, two million gallons of foreign ballast water are released every hour into U.S. waters (Carlton 1985). This possibly represents the largest volume of foreign organisms released on a daily basis into North American ecosystems. The introduction of exotic organisms threatens native biodiversity and could lead to changes in relative abundances of species and individuals that are of ecological and economic importance. This has already been observed in other parts of the world. While EFH has not been directly affected, recent introduction of a brown mussel into the Gulf of Mexico is of concern and is being investigated. It is anticipated that technology such as use of filters or open ocean exchange of bilge waters can be used to reduce the spread of non-native species.

Considering the extent of port development and shipping along the south Atlantic, addressing this issue is of paramount importance.

6.1.1.8 Inshore Mining

Inshore mining, as a category of EFH threats, is generally confined to a few specific locations where associated effects may be substantial. Between 1981 and 1996 the NMFS received only 434 of these proposals for review. Of these, 307 were from Florida and involved phosphate mining. While these activities undoubtedly have a dramatic effect on local landscapes and wetlands, the majority are well inland of most EFH locations. Where these activities occur along the coast, phosphate rock, sand, gravel, stone, and marl are generally mined. Phosphate rock is sought mostly for fertilizer production and the other materials are used mostly for fill, roadbed construction, and concrete production. The products of mining operations may eventually be transported to other locations and construction and operation of shipping facilities and navigation channels could involve EFH.

<u>Threats to EFH from Inshore Mining Activities</u>

Potential threats include conversion of wetlands to mine pits and uplands, or to reclaimed aquatic sites and uplands that lack pre-mine habitat and fishery production values; direct and/or non-point-source discharge of fill, tailings, chemicals, cooling and processing water, and surface and ground waters into streams, rivers and estuaries; hydrological modifications including those associated with ditches, dikes, water and waste lagoons, intake and discharge systems; and cumulative and synergistic effects associated with other mining and non-mining activities. Related shipping, storage, and processing facilities also can threaten EFH.

Where mining activities occur in areas identified as EFH, the local effect is often dramatic and extremely damaging. In eastern North Carolina phosphate mining has essentially eliminated an entire estuarine creek ecosystem in Beaufort County. The only phosphate mine in North Carolina is found in Beaufort County and located adjacent to the estuarine waters of Pamlico and South Rivers which are tributaries of Pamlico Sound. A 2006 proposal for continuation of mining would result in the loss of about 3,000 acres of wetlands of a variety of types, including the loss of approximately 30 acres of fresh and brackish estuarine emergent wetlands and freshwater/brackish water submerged aquatic vegetation located in the upper reaches of 5 estuarine creeks who's headwaters would be within the proposed mine expansion's footprint. Wetlands losses of this magnitude are significant on an ecosystem scale and the extent to which mitigation would offset these losses in uncertain at best. Alternative mining plans are available to the applicant that would be less damaging to wetlands and EFH; however, the company is opposed to these alternatives based on economics issues including profit margin. The resource agencies are obtaining an independent review of the company's economic data prior to preparation of a final Environmental Impact Statement for this project.

In Dade and Monroe Counties, Florida, limestone removal operations have converted large areas of wetlands to open pits. The majority of these operations occur in the "Lake Belt", which is an approximately 57,515-acre area that was established by the Florida

Legislature in 1997 for the purpose of implementing the Miami-Dade County Lake Belt Plan. The area lies west of Miami and east of Everglades National Park. To date, mining in the Lake Belt area has thus far has converted approximately 4,900 acres of freshwater wetlands into lakes. The Clean Water Act Section 404 permits authorized by the COE require the mining industry to fund acquisition, restoration, and long-term management of lands in the Pennsuco wetlands, which is the area sandwiched between the Lake Belt and the Florida Everglades.

While most state and federal regulations require restoration of mine sites, such action is costly and often fails to produce environments that are similar in ecological character and productivity to those that were destroyed. EFH designation could further fishery management opportunities in certain locations and in the case of certain mining activities. In locations where suitable mitigation cannot be provided, the creation of new mines and expansion of existing operations may be curtailed or prohibited. Other less intrusive mining operations, such as minor removal of sand and gravel, are likely to continue, but needed environmental protection measures (e.g., seasonal work restrictions) could be specified to minimize impacts to fishery resources and prevent significant harm to EFH. However, this is not always the case as illustrated by a proposed 750 acres mineral mining project in New Hanover County North Carolina that would adversely impact about 300 acres of tidally influences forested wetlands located adjacent to the Northeast Cape Fear River. The wetlands to be impacted and the adjacent waters in the river are designated as fish management areas by the North Carolina Division of Marine Fisheries and are therefore EFH. While approval of wetland losses of this type is unlikely, the frequency of this type of mining activity is likely to increase given the increase in development in coastal states and the need for aggregate fill for highway and commercial construction.

The construction and operation of mining-related facilities such as storage, processing, and shipping facilities and other related infrastructure such as roads, also presents a threat to EFH. Discussions found in Sections 4.1.1.6 and 4.1.1.7 address these factors.

6.1.1.9 Hydrologic Modifications

Alteration of freshwater flows into coastal marine waters, typically via the construction of canals, has changed temperature, salinity, and nutrient regimes, reduced the extent of wetlands, and degraded estuarine and nearshore marine habitats (Reddering 1988, Whitfield and Bruton 1989). The following summary is largely taken from Serafy et al (1997). Profound changes to the South Florida ecosystem have occurred with the construction of an extensive inland and coastal canal system by the COE which began as early as 1917 (Hoffmeister 1974, Teas et al 1976). Today, the system constitutes a 1400-mile network of canals, levees, locks and other flood control structures which modulates fresh water flow from Lake Okeechobee, the Everglades, and coastal areas. These areas, which serve as nursery areas for a wide diversity of organisms, have experienced drastic changes in both the amount of freshwater they receive, and in the fashion in which it is delivered. For example, in southern Biscayne Bay, Florida, canal locks are all that separate this occasionally hypersaline lagoon from the entirely freshwater canal systems. When the locks open, the salinity of marine waters downstream often drops 20 ppt within

60 minutes before recovering as rapidly (Wang and Cofer-Shabica 1988). This may occur several times a day and over several months, particularly during the rainy season (i.e., May to October) when water temperatures are also at maximum levels.

Potential Threats to EFH from Hydrologic Modifications

Most hydrologic modifications are performed with other activities that are identified as having potential to adversely impact EFH. As such, the activities involved are similar or identical to those identified in other sections. Other threats are possible with mosquito control, aquaculture, wildlife management, and flood control projects and activities. Hydrologic modification can involve entire watersheds and drainage basins for large scale water diversion projects, where silviculture and/or agriculture activities are large in scale and/or intensity, and where runoff from urban and suburban development is substantial. Threats related to hydrologic modification can involve any activity that alters water quality or the rate, duration, frequency, or volume at which water enters or moves through an aquatic system. Consequently, activities associated with industrial, urban, and suburban development (including those occurring on uplands), ditching, draining, diking, and impounding may all qualify as hydrologic modification related threats.

Rapid salinity fluctuations can represent a significant stress for a marine organism, depending on its osmoregulatory ability and/or its behavioral response (Serafy et al. 1997). In fishes, abrupt salinity changes can cause mineral imbalances in the blood which tends to become diluted as salinity drops, and concentrated as it rises -- either of which can be lethal (Mazeaud et al 1977). Rectification of proper osmotic balance in response to salinity stress requires energy expenditure, often at the cost of growth, reproduction and/or resistance to other stressors, including high temperature (Moore 1972, Schreck 1990). The combination of high temperatures and low salinity pulses on marine organisms has received only limited attention (Moore 1972, Albertson 1980). Only one study has examined the combined effects of high temperature and freshwater pulses on subtropical marine fishes of the Western Atlantic. Serafy et al. (1997) combined a field survey of nearshore fishes in Biscayne Bay, Florida, with a series of laboratory-based freshwater pulse experiments. A 13-month trawl project was supplemented with high temperature - low salinity challenge experiments on eight fishes: five species that dominated canal-influenced habitats (*Eucinostomus gula*, *Lagodon rhomboides*, *Haemulon sciurus*, *Opsanus beta*, and *Lucania parva*) and three species that were less common in these areas (*Cynoscion nebulosus*, *Haemulon favolineatum*, and *Cyprinodon variegatus*). Of the five fishes that dominated the nearshore habitats, three exhibited no mortality when subjected to freshwater pulses, while *L. rhomboides* and *L. parva* exhibited 12.5 percent and 50.0 percent mortality rates, respectively. Mortality was 100 percent for the three species that were less common in habitats influenced by canals. These laboratory and field results support the hypothesis that anthropogenic changes to fresh water delivery regimes can play a partial role in determining the species compositions of nearshore fish assemblages within Biscayne Bay, Florida.

Holland et al (1996) found that salinity was a major factor in controlling the distribution and abundance of living marine resources in South Carolina estuaries. In watersheds having the greatest areas of roofs, roads, and parking lots it was found that surface water discharges tended to be “flashier” and that recruitment and colonization by benthic fauna in these areas was less predictable than in more stable environments.

Mosquito control activities and associated threats to EFH have become better understood in recent years. Between 1996 and 2006, NMFS reviewed 203 applications for mosquito control and related activities in the South Atlantic area. Although efforts to alleviate the hydrologic modifications resulting from this activity are underway (27,000 acres of reconnected impoundments in the Indian River Lagoon) much of the area altered by ditching and draining of saltmarsh throughout the east coast has not been addressed. Although tidal water still flows into most of these saltmarsh areas it flows in prescribed dredged channels and does not interact with much of the marsh surface expect through extreme high tide events. Without sheet flow of water across the marsh surface much of the ecological benefit of saltmarsh is under utilized. Some of these areas are receiving hydrological restoration but efforts have been under funded and go largely unrecognized.

6.1.1.10 Dams, Impoundments, and Other Barriers to Fish Passage

Natural river systems throughout the world have been extensively modified for a variety of societal purposes including withdrawals for irrigation, public water supplies, navigation, flood control, and hydroelectric power. Over half of the world’s large river systems (172 of 292) are affected by dams constructed in the past century (Nilsson et al 2005). Approximately 800,000 dams have altered riverine habitats worldwide, with approximately 2 major dams constructed each day for the past 50 years (World Commission on Dams 2000). In the United States the total number of dams built during 1700- present is not known with certainty. The National Inventory of Dams (FEMA and U.S. Army Corps of Engineers 1994, 1996) listed approximately 76,000 dams including those deemed to be a threat to life and property downstream, those greater than 6 feet high with more than 50 acre-feet of storage, and those 25 feet or greater in height with more than 15 acre-feet of storage. The National Research Council estimated well over 2.5 million dams existed in the United States in 1992. All of the watersheds tributary to the South Atlantic Shelf Ecosystem are highly affected by large mainstem flood control and hydropower dams and many small dams constructed for various purposes. Bush, et al. (1998) in a review of existing dam location data identified 6,944 dams in South Atlantic watersheds (North Carolina to Florida).

Thousands of wetland acres have been impounded each year in the Southeast for purposes such as waterfowl habitat creation, aquaculture, agriculture, flood control, and mosquito control. Historically, large areas of wetlands were impounded in South Carolina for rice production. Projects range in size from minor, such as repair of existing embankments, to large-scale projects where constructing dikes and water- control structures may affect relatively large wetland tracts.

Numerous dams and other structures have been built on major rivers for industrial water uses, hydropower facilities, reservoirs, and as part of flood control projects. Those facilities near the coast can have an adverse effect by blocking fish passage, and modifying hydrology and sediment and nutrient flows to coastal waters. Dams affect or disrupt many natural processes including upstream and downstream movements of fish and other aquatic species, export of organic carbon, natural hydrological variability and seasonal flow patterns, seasonal temperature, dissolved oxygen and nutrient export patterns, and riverine, estuarine, and coastal geological processes (Freeman et al. 2003; World Commission on Dams 2000).

Potential Threats to EFH from Dams, Impoundments, and Other Barriers to Fish Passage

Direct effects of impoundments and other barriers are removal of habitat, conversion of habitat away from historic usage, alteration of hydrology, and modification of water quality by modification of temperature, salinity, and nutrient and sediment fluxes. Flow regimes often are controlled and differ substantially from pre-impoundment flows. This can adversely affect anadromous fish migration and spawning as well as food production for prey species needed by larvae and juveniles. Riverine, estuarine, and coastal marine ecosystems have evolved in synchrony with natural seasonal river flow variability and discharge patterns. Species life cycles, reproduction, and sustainable populations may be disrupted by man-made barriers and their many effects as described previously.

Large acreages of coastal wetlands have been impounded along the Southeast Atlantic. Reasons vary, but include aquaculture, waterfowl production, mosquito control, and in the Old South prior to 1912, rice production. The overall amount of impounded coastal wetlands is not known, but probably exceeds 200,000 acres. Between 1981 and 1996, the NMFS reviewed 721 proposals of varying sizes that blocked or impounded EFH (Tables 26-29). A review of 190 of these projects revealed that about 7,131 acres of EFH would be adversely altered through these projects. From 1996-2006, the NMFS Habitat Conservation Division received 465 applications for barriers and impoundments.

A primary biological concern for barriers and impoundments is the impact on estuarine-dependent marine fisheries production. Most impoundments are managed for resources other than fish (e.g., waterfowl). The management regimes, based largely on seasonal consideration, may exclude or severely restrict access by fish and invertebrates. This decreases habitat area and proportionately, the production of fishery resources. Even if fisheries gain access, conditions within impoundments may not be hospitable and organisms may not be able to escape and enter harvestable and reproductively active populations found in surrounding waters. Other management regimes, such as marsh burning, may adversely affect fishery resources. Water quality and nutrient outflow also may be compromised.

However, it is important to note that existing impoundments can be managed to reduce their impacts on estuarine habitat, although some impacts may remain, e.g., blockage of ingress-egress, reduction of carbon and nutrient export. New impoundments pose a potential risk to EFH and fish production and must be carefully evaluated. However, within the south Atlantic, some positive aspects are evident related to existing impoundments. Because wetlands have been extensively damaged, these areas (especially old rice fields) provide a wealth of available habitat. Further, production of fisheries organisms within these areas is often excellent. Crab production, for example, has been shown to be high in some areas and the production of many estuarine-dependent species has been observed.

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The effects of riverine dams and impoundments on riverine and coastal ecosystem processes, habitats, and health may be profound. Ecological functions of riverine ecosystems affected by dams may be grouped into five primary components: hydrology, biology, geomorphology, water quality, and connectivity (Instream Flow Council 2002). Each of the five components is strongly linked with physical habitat structure, important nutrient and carbon cycles, and health and productivity of estuarine and coastal marine ecosystems. Explained in simplest terms, the effects of dams are manifested through the broad impact categories of habitat fragmentation and flow regulation, in addition to alteration of morphological processes.

With respect to coastal ecosystems and managed fisheries, arguably the most critical effects of dams include blockage and consequent reduction in available reproductive habitat for sea-run diadromous fishes, and large-scale alteration of the distribution and periodicity of freshwater inflows.

Diadromous fishes including shad, herring and other alosines are important components of estuarine and marine food webs. Prior to construction of dams in Atlantic river basins large annual spawning runs of shad and herring and other diadromous species supported important coastal and river fisheries. Early accounts described annual spawning runs of shad and river herring in rivers including the Potomac, Susquehanna, Roanoke, and Savannah in the tens of millions (Baird 1887) with landings in individual river basins exceeding today’s total Atlantic Coast managed fishery landings by a wide margin. Baird was among the first marine scientists to suggest the relationship between diadromous fish biomass and support for stocks of other commercially important marine species. Construction of dams in Atlantic Coast river basins began soon after European colonization in the early 1700s and continued in cycles through the early 1970s (Watson 1996). Nearly all large river basins in the South Atlantic were closed to significant diadromous fish spawning runs by mainstem dams by the 1960s and 1970s. Busch et al. (1997) estimated the reduction in Atlantic Coast riverine habitats for diadromous species due to construction of dams. In the North Atlantic region (Maine to Connecticut) stream access for diadromous species has been reduced by 91 percent, and the corresponding reduction for the South Atlantic Region (North Carolina to Florida) is 77 percent. As dam construction progressed, along with unregulated exploitation and increasing pollution, the Atlantic Coast shad fishery remained one of the most economically important fisheries into the 1940s prior to construction of the last major mainstem dams after the Second World War (Hightower 1997). Today the formerly large spawning runs of shad, river herring, striped bass and sturgeon are reduced to small remnant populations or have disappeared entirely in some rivers. Because of the drastic reductions in abundance of shad and other alosine species, their importance in food web support has also diminished and may represent a significant limiting factor in recovery of some federally managed species.

The timing, duration, and frequency of river flows are critically linked to the health and function of riverine, estuarine and coastal marine ecosystems and fisheries (Taylor et al. 1990). Estuarine and coastal marine wetlands and deepwater habitats are highly dependent upon inputs of freshwater and associated nutrients and sediments from rivers (Berkamp et al. 2000). Seasonal periods of increased river discharge and consequent inflow to estuaries and coastal waters may serve as biological triggers for fish and invertebrate migrations and reproductive cycles. More prominent examples include upstream spawning movements of shad, striped bass, and sturgeon to spawning habitats in river channels; and movements of spawning blueback herring and Atlantic menhaden into floodplain forested wetlands and deepwater sloughs (Rulifson 1982; Pardue 1983; Meador 1982). Natural seasonal patterns and variations in freshwater inflows to estuarine and coastal marine habitats provide suitable salinity and nutrient conditions for reproduction and growth of oysters, blue crabs, shrimp and many estuarine-dependent species. Regulation of river flows by dams, particularly for flood control and hydropower production, may significantly alter natural patterns of river discharge to which many species life cycles have adapted during their evolutionary history. River regulation may affect seasonal salinity patterns over large areas of estuarine and coastal marine habitats. Dams with large storage capacity can reduce downstream flows during critical late winter and spring diadromous fish migrations, resulting in reduced water level and duration and areal extent of inundation, severely limiting fish production. Dams and reservoirs trap river-borne sediments, resulting in reduction of nutrient-rich sediment deposition in downstream floodplain wetlands and alluvial deltas. Resulting disruption of alluvial delta and wetland formation processes may cause large scale floodplain and wetland subsidence, adversely affecting habitat stability and productivity for estuarine and coastal marine fisheries.

Thermal stratification of large reservoirs during summer months often results in biological oxygen depletion of the cooler water of the hypolimnion, with consequent discharge of cooler water with low dissolved oxygen downstream of the dam. Fish and other aquatic life may be eliminated or adversely affected in riverine or estuarine areas downstream as far as the deoxygenation persists. Large, shallow impoundments lacking thermal stratification may result in solar warming with consequent release of water with elevated temperatures to downstream riverine and estuarine habitats. During warmer summer months, the resulting elevated water temperatures may exceed the tolerance levels for fish species adapted to naturally occurring seasonal temperature regimes. Where dams and river regulation have been in place for many years, the continuing cumulative effects of habitat fragmentation, altered flows, water temperatures, and dissolved oxygen conditions may result in shifts in aquatic species community structure and composition. Populations of federally managed diadromous, estuarine and marine species may be limited by the continuing effects of dams and river regulation.

Dams and other barriers have been constructed on almost every major southeastern river. They serve multiple purposes including hydropower production, water supply, and flood attenuation. Dams located on the Roanoke and Neuse Rivers in North Carolina, the Cooper and Santee Rivers in South Carolina and on the Savannah River on the South Carolina-Georgia border are major impediments to anadromous fish migrations, as mentioned above. Most of these structures are old and were built either before their effects on fish and other wildlife were known, or at a time when environmental concerns were of lesser importance than economic and political factors. Considering the present level of knowledge of their effect on fish migration and production, water quality, and flow alteration, it is unlikely that major new structures will be built. The present challenge is to revisit older structures to determine their usefulness and where their negative impacts outweigh their benefits, they should be removed or modified. An example is removal of the Quaker Neck Dam on the Neuse River in North Carolina. Where removal is not feasible then consideration must be given to providing for, or improving fish passage and for modifying flow regimes to mimic pre-impoundment flows. These considerations will rely on new research and improvements in fish passage technologies.

6.1.1.11 Other sources of nonpoint-source pollution

Potential Threats to EFH from Other Sources of Nonpoint Source Pollution

Potential threats include reduced water quality, erosion, increased contaminants, increased sedimentation, and disease.

The more common sources of NPS pollution include runoff from agriculture, pasture lands, silviculture, mining, and developed areas as well as erosion created from modifying rivers, streams, and shorelines. These sources have separate sections in the Fishery Ecosystem Plan. Three additional sources of NPS runoff deserve brief mention and include construction sites, marinas, and septic systems

Runoff from construction sites can be considerable sources of NPS pollution (Carpenter et al. 1998). Construction sites occupy a relatively small percentage of land surface area, but rates of erosion from these sites can be high leading to a large amount of pollution coming from these small areas. Erosion rates from watersheds under development can approach 50 times the rate from agriculture lands and 500 times the rate from areas with undisturbed plant cover. Eroded material from construction sites contributes to siltation of water bodies as well as eutrophication. Best management practices for controlling runoff from construction sites are well known and should be followed to avoid impacting fishery resources.

Understanding NPS pollution associated with marinas can be difficult because marinas can be both a source of pollutants generated by activities occurring within the marina as well as the place where pollutants generated elsewhere collect (Flory 2005, USEPA 2001). Construction of the basins, docks, jetties, and bulkheads needed for marina operations typically reduce water circulation, and this reduced circulation promotes the settling of fine sediments that often have organic material, metals, or other pollutants attached to them. These materials concentrate in marina sediments and, at times, also can concentrate in marina waters. The pollutants that might be generated at a marina or accumulate within a marina basin include nutrients and pathogens (from pet waste and overboard sewage discharge), sediments (from parking lot runoff and shoreline erosion), fish waste (from dockside fish cleaning), petroleum hydrocarbons (from fuel and oil drippings and spills and from solvents), toxic metals (from antifouling agents and debris from boat maintenance), and liquid and solid wastes (from engine and hull maintenance and general marina activities).

Many contaminants generated from boat maintenance and general marina use (e.g., oil and grease drippings from cars) are insoluble in water. In the slow flowing, protected waters of the marina, the fine particles that these materials adhere to settle accumulate in the sediments. While these sediments may then release their contaminants into the water in response to physical disturbance (such as dredging, propeller wash, or storms) or from changes in water chemistry (such as pH or dissolved oxygen concentration), effects upon benthic organisms and fishery resources are of greatest concern. Most benthic organisms either burrow into the sediment or feed by sorting through large volumes of sediment in search of prey items or detritus. Both behaviors bring benthic organisms into close contract with any contaminants that may be present and these contaminants can then accumulate in the bodies of the benthic animals. Fishery species that feed upon these benthic organisms are then exposed to concentrated doses of the contaminants, which may reduce the health or reproduction of the fishery individuals or make them unsuitable for consumption by humans.

Pollutants from marinas can cause pollution problems in the water column. These problems usually take the form of decreased levels of dissolved oxygen and increased levels of metals and petroleum hydrocarbons. Pollutants that cause these problems get into the water through storm water runoff, discharges from boats, and spills of fuel or bilge water. Low levels of dissolved oxygen can be a problem any place where organic material accumulates. The decay of organic material consumes oxygen from surrounding water. If the low circulation promotes accumulation of organic material while at the same time hindering exchange with oxygen-laden waters outside the marina, the result can be insufficient oxygen for fishery species.

In addition to pollutants that reduce the quality of sediment or the water, marinas often are associated with silt that can impair seagrass, oyster, or other habitats that support fishery resources. Increased boat traffic within and near a marina can erode shoals and the shoreline suspending large amounts of sediment into the water that fall upon fishery habitats. Waves generated by boat wakes can wash away seagrass that is loosely rooted in sediments and the benthic organism living at the sediment surface.

NPS pollution associated with marinas can be reduced by ensuring marinas are designed to flush regularly with adjacent waters; locating marinas close to tidal inlets and away from the headwaters of tidal creeks is part of these design decisions. Shorelines should be vegetated to reduce erosion. Stormwater runoff can be controlled by well designed and maintained stormwater management systems. Marina fueling and sewage collection stations should be maintained and designed to make cleanup of spills easier.

Septic systems include the underground system of pipes and tanks designed to use naturally occurring bacteria and microorganisms to treat bathroom, kitchen and laundry wastewater. In older homes, a septic system may be little more than a cesspool and a pipe that connects the cesspool to the house. In newer homes, a septic system usually includes a septic tank, distribution box, drain field, and pipes that connect these elements. Passing sewage and household wastewater through a septic system protects the environment from contamination. Microorganisms and insects living within the drain field help decontaminate waste materials by consuming leftover waste particles. Improperly maintained septic systems can allow nutrients and pathogens to enter ground waters and surface waters that flow into coastal ecosystems. The excess nutrients can lead to eutrophication and low levels of dissolved oxygen, both of which can impair habitats used by fishery species. The pathogens can spread disease that reduce the health of fishery species.

NPS pollution from septic systems can be reduced by ensuring the systems are inspected annually and pumped regularly. Pumping out every three to five years is recommended for a three-bedroom house with a 1,000-gallon tank; smaller tanks should be pumped more often. Storm drains should not be diverted into septic systems because the extra load on the systems will overwhelm its ability to process nutrients and eliminate pathogens. Any measure that decreases water use within a home can help a septic system protect coastal water quality by reducing the likelihood of overflow from the system.

6.1.1.12 Non-native or nuisance species

Update on Aquatic Invasive Species Management in the Southeast-March 2008

Marilyn Barrett-O’Leary Southeast Aquatic Resources Partnership (SARP)

Aquatic invasive species are a part of fisheries and wildlife management in all of the Southeast Aquatic Resources Partnership (SARP) states. Many of the states manage specific species cooperatively, but we do not have comprehensive regional management. For example, Texas and Louisiana partnered with some federal agencies to bring massive chemical control to reduce a giant salvinia infestation on Caddo Lake, a popular angling lake on the two states’ shared border. Florida, a state with better funding resources than many of its neighbors, routinely shares research results and outreach products (on many invasive plants and animals) to promote regional control. All of the states are members of at least one regional Aquatic Invasive Species (ANS) panel, providing biannual meetings to share information and committees to work on problems regionally.

Every SARP state has developed an ANS management plan. Most have completed that process, which involves forming a task force, gathering information, identifying overlapping jurisdictions, setting priorities, and devising action plans. Most important, these activities lead to governor's buy in and signature, interagency agreements such as MOUs, and continuation of the task force in some form to facilitate management. As of this date, every SARP state has at least one agency person with ANS as part of his/her scope of work. Some have individuals with ANS as his/her exclusive scope of work.

The states of Louisiana, Texas, Florida, Virginia and Missouri have officially accepted plans. Kentucky, South Carolina, Alabama, Tennessee and Mississippi are in the final, official stages of seeking national acceptance of their plans. They have effectively identified the problem and are already integrating solutions into their agency activities. Oklahoma, Georgia, North Carolina, and Arkansas are still developing their plans. Both Georgia and North Carolina are developing plans that combine management of terrestrial and aquatic invasive species. All states are aware of the need to work in that direction.

All of these states face similar issues. Below are a few of them:

1. Invasive species are not all bad or all good – they may cause problems in certain circumstances but actually benefit certain groups or situations. Management (treatment, regulation, education) requires ecological and economic evaluation on local, regional, and national levels and cooperation among state, local, and federal agencies.

2. Invasive species almost always alter the ecosystem; they seldom simply slip into an unfilled niche. They thrive in disturbed systems. Therefore, ecological management can contribute to invasive species prevention and control. Unfortunately, states are not funded or equipped to manage all state waters at that level, and every state has many waterbodies that are managed privately or by federal agencies.

3. The general population has only fleeting knowledge of this problem, and often, unwittingly, contributes to it. Consistent, continuous education is needed over the long term. SARP agencies are trying to educate one of the most involved segments of the population – the recreational fisher – to clean off boats before leaving the dock, place unused live bait into the trash rather than dumping it into the water, and to refrain from moving live fishes in an attempt to 'stock' for certain fish. Similar, targeted education efforts need to be made towards many other population segments. Tax dollars need to be earmarked for this management.

6.1.2 Marine/offshore processes

6.1.2.1 Navigation

Offshore maintenance dredging for navigation is mainly limited to inlet bar channels and other port entrances; e.g., Port Canaveral, Florida. The sediments are typically coarse and the bottom communities are low diversity reflecting the dynamic nature of these areas. Bottom organisms occupying this zone are generally sparse and adapted to the dynamic nature of the habitat they occupy. As such, dredging in these locations generally does not pose the same magnitude or type of impact incurred when working in nearshore environments. The same is true for vessel operations, although to some degree the problems discussed in Section 4.1.1.6 also apply. Vessel operation impacts are mainly linked to sinking, grounding, routine disposal trash and wastes, and the accidental release or spillage of cargo and fuel.

However, offshore new dredging, namely widening and deepening existing port entrance channels to accommodate super-carriers, i.e. Post-Panamax vessels (also see section 4.1.1.6.1), for navigation can impact complex hard bottom communities along channel walls in addition to reef trends. For example, the Jacksonville District COE in conjunction with Port Everglades is presently completing a feasibility study in part to evaluate the widening and deepening of the Port Everglades Outer Entrance Channel. The project could impact offshore marine habitats, including hard bottom and coral reef communities located offshore Fort Lauderdale, Florida (Broward County). In total, 11.9 acres of hard bottom habitat on the outer reef (Reef 3) may be removed during construction (COE, 2006).

Potential Threats to EFH from Navigation

Potential threats include excavation and burial of EFH in connection with creation, expansion and maintenance of navigation channels; elevation of turbidity and resuspension of toxic and harmful components of dredged materials (includes material that cause elevated sediment and dissolved oxygen demands); interruption of coastal sand movement and sub-adult fish migration through construction of channel stabilization structures such as jetties; potentially harmful vessel operations such as discharge or spillage of fuel, oil, grease, paints, solvents, trash, and cargo; grounding/sinking/prop scaring 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.

With a few exceptions, offshore dredging is performed using hopper dredges. Hopper dredges generally dump accumulated material through a split hull; however, the use of these dredges in connection with pipelines and vessel pump out is becoming more commonplace, especially where sand is needed for beach fill. Closer inshore, sidecast dredges may be used where wave amplitude is slight and dredging volumes are relatively minor. In protected waters pipeline dredges are almost always used since they provide the most effective and efficient means for removing and redepositing bottom sediments. On rare occasion, as in the case of the Cape Canaveral Ship Channel, pipeline dredges may be used in open waters but their vulnerability to wave damage generally precludes this. Bucket dredges and scows are employed in some locations, but such use is usually limited to situations where other dredges cannot operate due to water depth and pumping distances (for pipeline dredges).

In connection with offshore waters, threats to EFH are most significant in terms of possible burial of benthic communities in the vicinity of dump sites and in connection with turbidity from dumped materials. Contamination of the water column and bottoms is also possible if the dredged material is contaminated. Sediments may also be re-dispersed after being dumped in offshore sites and burial of productive bottoms is possible. On occasion, designated dump sites are not adequately studied or they change and high quality benthic habitat may be damaged or destroyed.

Although most ports are located in estuarine waters, navigation related threats can also be severe in offshore waters. As the shipping industry moves towards super containerships, the many eastern seaboard ports are evaluating the need to widen and deepen offshore entrance channels. Currently, only a limited number of Ports can accommodate Post-Panamax vessels. The Port of New York/New Jersey is the only port along the Atlantic seaboard that is undergoing expansion work to support super-carriers.

Additional threats to EFH from offshore navigation occur through the overboard disposal of trash, cargo, and wastewater from ocean going vessels (see Section 4.1.1.2.), and disposal of dredged material (see Section 4.1.2.2). Although comparisons are unavailable, it is likely that most vessel-related disposal occurs on the open ocean, rather than in estuarine and nearshore waters where such activities are likely to be observed. Within Florida waters, particularly in the Florida Keys and Fort Lauderdale, vessel groundings represent a chronic threat to live coral habitat. Anchoring is also a problem, however, it has become less of a threat through wide spread use of single point mooring buoy systems. Vessel groundings can be broken into two broad categories: large vessel and ship groundings that often result in severe injury to live coral colonies and non-living reef framework; and small recreational boat groundings that result in numerous strikes to individual coral colonies in both inshore and offshore areas. Large vessel and ship groundings occur infrequently, but result in far more significant injury to coral reefs and other habitat types. Recreational boat groundings are much more frequent. Between 1993 and 1997, 2089 groundings were reported in the Florida Keys National Marine Sanctuary. Many more are likely unreported.

Table 6.1-1 Reported Vessel Groundings* in Florida Keys National Marine Sanctuary (FKNMS) 1993 to 1997.

Year	Total Reported Vessel Groundings
1993	280
1994	550
1995**	400
1996**	399
1997**	460
Total	2089

*Data from FKNMS & Florida Marine Patrol Computer Assisted Dispatch Report
** Grounding data for 1995 through 1997 are incomplete and require further data analysis.

Note: The above numbers do not represent coral reef groundings alone. Reported groundings occur in all types of habitats found in the FKNMS.

Accurate baseline data for live coral coverage exist mainly for reefs in the Florida Keys but not for the remaining habitat that contains stony corals that do not form reefs. In some cases though, sufficient data are available to allow calculation of the actual extent of a grounding incident. For example, on August 10, 1994, the R/V *Columbus Iselin*, a 154-foot research vessel, was conducting survey work for the University of Miami when it struck Looe Key, a spur and groove reef. Approximately 345 square meters of living coral and 338 square meters of non-living coral reef framework were destroyed.

Injuries to coral from groundings take several forms and include crushing, splitting and fragmentation, dislodging colonies, and depending on the severity of the incident, sedimentation and/or burial. In general, groundings occur on or near the reef crest where coral formations are closest to the water surface. Species commonly injured in the reef crest include elkhorn coral (*Acropora palmata*), staghorn coral (*A. cervicornis*), fire coral (*Millepora complanata*), starlet coral (*Siderastrea siderea*), mustard hill coral (*Porities astreoides*), and knobby zoanthidean (*Palythoa mammillosa*). Species that inhabit deeper areas such as brain coral (*Diploria strigosa*), star coral (*Montastrea annularis*), and large star coral (*Montastrea cavernosa*) are at risk from deep draft vessels. Small individual groundings may recover over time, but the loss of live coral coverage is likely to take decades. Catastrophic groundings involving large ships or freighters may never fully recover.

Since 1994, there have been at least 10 reported large-scale groundings near the existing anchorage off Port Everglades (in Florida) that have collectively damaged over 3 acres of coral reef habitat. The existing shallow water anchorage is located between two lines of reef. Dozens of undocumented anchor and anchor chain drag impacts have also occurred damaging an undetermined amount of reef. The U.S. Coast Guard has proposed anchorage rulemaking to revise the existing anchorage locations to strengthen existing anchoring requirements and guidelines in order to provide a higher degree of protection to the reef resources.

6.1.2.2 Dumping

Dredged material disposal in ocean waters generally involves disposal of sediments dredged from inshore areas such as port facilities. Where navigation approaches from offshore and inlets are involved these materials may also be placed in offshore sites. Most of the sediments taken from inshore areas are fine, contain some degree of contamination, and produce at least short-term impacts such as turbidity plumes when removed or deposited. The overall effects of dumping on or near EFH can range from immeasurable to significant and are not well studied. Therefore, dredging and disposal are typically evaluated on a case-by-case basis. The SAFMC policy on dumping (see Section 5.3.1) provides additional detail on the subject. The principal authority for designating ocean disposal sites for placement of dredged material is the Regional Administrator of the EPA. The EPA develops and publishes Environmental Impact Statements (EIS) and the rule making paperwork for ocean dredged material disposal site (ODMDS) designations. Corps of Engineer Districts provides the EPA with the necessary information to prepare the EIS and to identify significant issues to be addressed in the site designation process. Information required from the Districts includes: zone or siting feasibility data, justification for the need for ocean disposal, and alternatives to ocean disposal. The purpose of the EPA site designation process (see Appendix K) is to establish sites that minimize impacts to the environment, economize disposal site management and monitoring activities, and support multiple users (C. McArthur personal communication).

Under provisions of the Marine Protection Research and Sanctuaries Act (MPRSA), ocean disposal of hazardous and toxic materials, other than dredged materials, is prohibited by U.S. flag vessels and by all vessels operating in the U.S. territorial sea and contiguous zone. The EPA may issue emergency permits for industrial waste dumping into ocean waters if an unacceptable human health risk exists and no other alternative is feasible. The MPRSA assigns responsibility the ocean disposal of dredged material to the EPA and the COE. This involves designating ocean sites for disposal of dredged material; issuing permits for the transportation and disposal of the dredged material; regulating times, rates, and methods of disposal and the quantity and type of dredged material that may be dumped; developing and implementing effective monitoring programs for the sites; and evaluating the effect of dredged material disposed at the sites (C. McArthur personal communication).

To date, offshore ocean dumping sites have been approved for ports at Wilmington, North Carolina; Brunswick and Savannah, Georgia; Georgetown, Charleston and Port Royal, South Carolina; and Miami, Palm Beach, Port Everglades, Fort Pierce, Jacksonville, and Fernandina Beach, Florida (C. McArthur personal communication). The COE has identified Jacksonville Harbor as possibly needing a new or expanded ODMDS.

Table 6.1-2 Region IV of the U.S. Environmental Protection Agency identifies the following concerns in connection with existing South Atlantic Ocean Dredged Material Disposal Sites (ODMDS):

Ocean Dredged Material Disposal Site	Site Specific Concerns
Charleston, SC ODMDS	Live bottom areas proximal to the site subject to possible impact.
Miami, FL ODMDS	Effect of disposal plumes on nearshore coral reefs are under investigation.
Port Everglades, FL ODMDS	Burial of deepwater hard bottoms and shelf edge zones that support managed species. Conversion of sediment type could affect tilefish burrows. Possible presence of deepwater corals (e.g. *Oculina varicosa*).
Palm Beach, FL ODMDS	Burial of deepwater hard bottoms and shelf edge zones that support managed species.

Fort Pierce, FL ODMDS	Conversion of sediment type could affect tilefish burrows. Possible presence of deepwater corals (e.g. *Oculina varicosa*). Offsite transport of disposed dredged material and subsequent burial of nearby hard bottom communities is of concern to local community.
Jacksonville, FL ODMDS	Lies within Northern Right Whale Critical Habitat and site may be undersized.
Fernandina, FL ODMDS	Lies within Northern Right Whale Critical Habitat.
Brunswick, GA ODMDS	Lies within Northern Right Whale Critical Habitat.
Wilmington, NC ODMDS	Wood debris in dredged material suspected of migrating off site into shrimping grounds.

Dumping of trash, wastewater, and unwanted cargo is more likely to occur on the open seas since it is less observable here than in inshore waters. Prior to passage of the Marine Plastic Pollution Research and Control Act (MPPRCA) of 1987 (PL 100-220), an estimated 14 billion pounds of garbage were being dumped into the ocean each year. More than 85 percent was believed to have come from the world's shipping fleet in the form of cargo-related wastes. See section 6.1.2.2.3 below.

Potential Threats to EFH from Dumping

Potential threats include burial of habitats and their flora and fauna, introduction of contaminants and toxic substances into waters and substrates, increased and harmful turbidity levels, and creation of hazards to fishing and navigation.

Threats associated with ocean dumping sites include covering of live bottom or hard bottom areas in or near a dump site; disposal of fish processing wastes; converting the sediment type in areas that support tilefish; impacts to nearshore coral reefs and live bottoms by disposal plumes; offsite transport of disposed dredged material and subsequent burial of nearby hard bottom communities; designated sites that are too small to handle the load; migration of debris (e.g., wood) to fishing grounds; derelict vessel disposal; and the location of dumping sites within critical habitat of endangered species such as the northern right whale.

Because monitoring of disposal activities is sometimes inadequate, there are reports of dredged material dumping outside of designated dump sites (short dumping). One recent example of a possible short dumping event involves the excavation associated with the Fort Pierce Harbor, Florida, expansion project. In this case, over 400,000 cubic yards of dredged material from this project was dumped at a mid-shelf site. Numerous complaints arose thereafter from fisherman and divers that the fill was short-dumped and large areas of reef habitat had been covered. These sites had previously served as productive snapper/grouper fishing locations. EPA Region IV undertook a number of studies into this issue. EPA monitoring reports are available at http://www.epa.gov/region4/water/oceans/sites.htm#ftpierce. Reed (1996) summarizes information available at the time regarding the mud deposits potentially derived from this event.

Another documented example of dumping occurring outside the designated ODMDS occurred during the Charleston Harbor Deepening Project. A total of 53 documented incidents of unauthorized disposal activity outside the ODMDS were reported subsequent to dredging for the Charleston Harbor Deepening Project. The unauthorized dumps were first detected during a routine assessment of the ODMDS and surrounding area using side scan sonar (Jutte et. al. 2001). The documented dumps placed large quantities of mud and clay on sandy bottom habitat, with some located very near hard bottom reef habitat. Subsequent surveys over a four year period to determine whether movement of material from these sites or the ODMDS was having an adverse impact on nearby reef habitats did not identify clear loss of habitat with the exception of one site located closest to the ODMDS. The abundance finfish and large sessile invertebrates, such as sponges and corals also did not appear to be adversely affected during the survey period (Crowe et al. 2006).

In areas that have been suspect of short-dumping, such as the ODMDS located offshore the Port of Miami, the EPA Region IV and NMFS habitat office have developed additional permit conditions that include:

1. The permittee shall use an electronic positioning system to navigate to and from the ODMDS;
2. The permittee shall certify the accuracy of the electronic positioning system proposed for use during disposal operations at the ODMDS;
3. The permittee shall not allow any water or dredged material placed in a hopper dredge or disposal barge or scow to flow over the sides or leak from such vessels during transportation to the ODMDS;
4. A disposal operations inspector and/or the captain of any tug boat, hopper dredge, or other vessel used to transport dredged material to ODMDS shall ensure compliance with disposal operation conditions defined in this permit;
5. If the disposal operations inspector or the captain detects a violation, he or she shall immediately report the violation to the relevant county Seaport Department, the Corps of Engineers District, and to NMFS;
6. When dredged material is disposed, no portion of the hopper dredge or disposal barge or scow shall be farther than 500 feet of the center of the ODMDS;
7. The permittee shall use an automated disposal verification system that will continuously track (1 minute intervals) the horizontal location and draft condition of the disposal vessel (hopper dredge or disposal barge or scow) to and from the ODMDS;
8. The required digitally recorded data should include: date, time, vessel name, dump number, beginning and ending coordinates of the dredging area for each load, location at points of initiation and completion of disposal, description of

material disposed (rock rubble, sand, clay or silt), volume of load, and disposal technique;
9. The permittee shall conduct a bathymetric survey of the ODMDS within 30 days following project completion;
10. The number and length of the survey transects shall be sufficient to encompass the ODMDS and a 0.25 nautical mile wide area around the site. The transects shall be spaced at 500_foot intervals or less;
11. Vertical accuracy of the survey shall be ±0.5 feet; and
12. At the dredge site, barges must be either lashed to dredges or cables must be floated to avoid impact to submerged resources.

Similarly, at the Charleston ODMDS site a number of constraints similar to those used in Miami were adopted, and it also included limiting the barge traffic to areas that were outside know hard bottom habitat.

Even with the use of approved practices and disposal sites, ocean disposal of dredged materials is expected to cause environmental harm since contaminants will continue to be released, productive bottoms will still be buried, and localized turbidity plumes and reduced oxygen zones will persist. Further, analyses are needed for use in dump site designation. For example, there have already been observed cases (e.g., at Charleston) where dump sites were designated and then, after dumping had been initiated, it was determined that valuable hard bottom habitats were located in or near the dump site. However, at the Charleston Harbor site, while it was determined that valuable hard bottom habitat is located adjacent to the dump site, monitoring has confirmed that construction of a berm along the edges of the disposal site is containing the majority of the dredged material, with the exception of occasional missed targeting and these are generally in the vicinity of the adjacent channel from which the vessel is traversing.

The effects of new disposal techniques such as creation of nearshore berms and "beneficial uses" of dredged material such as creation of shallow water habitats and emergent wetlands are, in many cases, unclear and may cause long-term geomorphological and ecological change that is harmful to certain species and environments. In the Charleston ODMDS, the deepening project included the construction of large berms along the border of the ODMDS that were composed primarily of cooper-marl material that would stay in place. The logic for constructing these berms was to inhibit significant movement of the disposed material within the ODMDS to sensitive bottom habitats located nearby. This effort appeared to be successful based on subsequent monitoring activities (Crowe et al. 2006). The SAFMC recognizes offshore berm construction as a disposal activity. As such, its policies regarding disposal of dredged materials apply. The SAFMC also recommends that research should be conducted to quantify larval fish and crustacean transport and use of inlets prior to any consideration of placement of underwater berms. Until the impacts of berm creation in inlet areas on larval fish and crustacean transport are determined, the SAFMC recommends that disposal activities should be confined to approved ODMDS. The SAFMC further believes that new offshore and near shore underwater berm creation activities should be reviewed under the most rigorous criteria and on a case-by-case basis.

In the absence of MPRSA and MPPRCA repeal or weakening, major dumping threats to EFH within federal waters should be limited mostly to illegal dumping and accidental disposal of material in unapproved locations. However, many agencies lack sufficient staff and funds to carry out mandated responsibilities and the opportunity for illegal and accidental dumping may be substantial. The effect of insufficient monitoring and enforcement is evident by the tons of debris, sometimes including hazardous materials such as syringes and medical wastes that are deposited along the nation's beaches every year.

As noted in Section 4.1.2.2 (above) the SAFMC has developed Policies for disposal of dredged material in waters under its jurisdiction. With regard to use of Ocean Dredged Material Disposal Sites (ODMDS) the policy provides that:

- ODMDS should be designated or re-designated so as to avoid the loss of live or hardbottom habitat and minimize impacts to all living marine resources.
- Notwithstanding the fluid nature of the marine environment, all impacts from the disposal activities should be contained within the designated perimeter of the ODMDS.
- The final designation of ODMDS should be contingent upon the development of suitable management plans and a demonstrated ability to implement and enforce that plan.
- The Council encourages EPA to press for the implementation of such management plans for all designated ODMDS.
- All activities within the ODMDS are required to be consistent with the approved management plan for the site. The Council's Habitat and Environmental Protection Advisory Panel when requested by the Council will review such management plans and forward comment to the Council. The Council may review the plans and recommendations received from the advisory sub-panel and comment to the appropriate agency.
- ODMDS management plans should specify those entities/ agencies which may use the ODMDS, such as port authorities, the U.S. Navy, the Corps of Engineers, etc. Other potential users of the ODMDS should be acknowledged and the feasibility of their using the ODMDS site should be assessed in the management plan.
- Feasibility studies of dredge disposal options should acknowledge and incorporate ODMDS in the larger analysis of dredge disposal sites within an entire basin or project. For example, Corps of Engineers' analyses of existing and potential dredge disposal sites for harbor maintenance projects should incorporate the ODMDS as part of the overall analysis of dredge disposal sites.

6.1.2.3 Marine Debris

One of the more conspicuous byproducts of commercial and recreational boating activities in coastal environments is the discharge of marine debris, trash, and organic wastes into coastal waters, beaches, intertidal flats, and vegetated wetlands. 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. In laboratory studies, Hoss and Settle (1990) demonstrated that larvae of estuarine-dependent fishes including Atlantic menhaden, spot, mullet, pinfish, and flounder consume polystyrene microspheres. Investigations have also found plastic debris in the guts of adult tuna, striped bass, and dolphin (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. Most media attention given to marine debris and sea life has focused on threatened and endangered marine mammals and turtles, and on birds. In these cases, the animals become entangled in netting or fishing line, or ingest plastic bags or other materials. Recently, a 35-foot- long sperm whale stranded and died in North Carolina due to ingestion of a plastic float, plastic jugs, a large piece of rubber, 50 feet of nylon rope, and a large plastic bag (D. Engel personal communication).

The production of plastic resin in the U.S. increased from 6.3 billion pounds in 1960 to 47.9 billion pounds in 1985. The increased production, utilization, and subsequent disposal of petro-chemical compounds known as plastics has created a serious problem of persistent marine debris. Marine ecosystems have, over the years, become the final resting place for a variety of plastics originating from many ocean and land-based sources including the petroleum industry, plastic manufacturing and processing activities, sewage disposal, and littering by the general public and government entities (commercial fishing industry, merchant shipping vessels, the U.S. Navy, passenger ships, and recreational vessels) (Department of Commerce, 1988c).

Effective January 1, 1989, the disposal of plastic into the ocean is regulated under the Plastic Pollution Research and Control Act of 1987, implementing MARPOL Annex V. Recognizing worldwide concern for preservation of our oceanic ecosystems, the Act prohibits all vessels, including commercial and recreational fishing vessels, from discharging plastics in U.S. waters and severely limits the discharge of other types of refuse at sea. This legislation also requires ports and terminals receiving these vessels to provide adequate facilities for in-port disposal of non-degradable refuse, as defined in the Act.

The utilization of plastics to replace many items previously made of natural materials in commercial fishing operations has increased dramatically. The unanticipated secondary impact of this widespread use of plastics is the creation of persistent marine debris. Commercial fishing vessels have historically contributed plastics to the marine environment through the common practice of dumping garbage at sea before returning to port and the discarding of spent gear such as lines, traps, nets, buoys, floats, and ropes. Two types of nets are routinely lost or discarded drift gill nets and trawl nets (Department of Commerce 1988c). These nets are durable and may entangle marine mammals and endangered species as they continue to fish or when lost or discarded.

An estimated 16 million recreational boaters utilize the coastal waters of the United States (Department of Commerce, 1988c). Disposal of spent fishing gear (e.g. monofilament fishing line), plastic bags, tampon applicators, six pack yokes, styrofoam coolers, cups and beverage containers, etc. is a significant source of plastic entering the marine environment.

In the mid 1970s, the National Academy of Science (NAS) estimated that approximately 14 billion pounds of garbage was disposed of annually into the world's oceans. Approximately 85% of total trash is produced from merchant vessels, with 0.7% of that total, or eight million pounds annually being plastic. The use of plastics has risen dramatically since the NAS study. In 1987 20 percent of all food packaging was plastic and by the year 2000 this figure was expected to rise to 40 percent (CEE, 1987).

The main contribution of plastic to the marine environment from cruise ships is the disposal of domestic garbage at sea. Ships operating today carry between 200 and 1,000 passengers and dispose of approximately 62 million pounds of garbage annually, of which a portion is plastics (CEE, 1987).

The U.S. Navy operates approximately 600 vessels worldwide, carrying about 285,000 personnel and discharging nearly four tons of plastic refuse into the ocean daily (Department of Commerce, 1988a). The U.S. Coast Guard and NOAA operate 226 vessels which carry nearly 9,000 personnel annually and have internal operating orders prohibiting the disposal of plastic at sea. MARPOL Annex V does not apply to public vessels although the Plastic Pollution Research Control Act of 1987 requires all Federal agencies to come into compliance by 1994 (CEE, 1987).

6.1.2.4 Offshore Sand and Mineral Mining and Beach Fill

To date, offshore mining for minerals has not been a significant issue in the south Atlantic region (oil and gas mining is discussed separately). However, several pending proposals are under regulatory consideration. Earlier consideration of mining for manganese nodules and removal of useable materials and metals from seawater have not materialized, probably due to market conditions. Recent discovery of large phosphate deposits in waters off North Carolina could eventually lead to requests to mine these deposits. As readily available upland sources of minerals and other materials are depleted, the extraction of marine deposits will become more feasible and likely to occur. The mining of sand for beach nourishment presents a large, complex, and politically charged threat to EFH in the southeast. Between 1981 and 1996, the NMFS reviewed more than 200 dredge proposals to nourish beaches. Between 1996 and 2006, NMFS reviewed an additional 312 dredge proposals to nourish beaches. Most of these projects are large in scope and affect miles of coastline and nearshore habitats. Where sand is removed from nearshore environments, channels, and inlets, additional EFH alteration is possible due to a number of factors such as down drift erosion and removal of materials that eventually nourish shallow waters located behind barrier islands. A survey of 120 of the more than 200 beach nourishment projects received by the NMFS showed that about 5,735 acres of aquatic sites were subject to excavation and filling.

The Federal Outer Continental Shelf (OCS) contains large sand deposits that MMS anticipates could serve as long-term sources of borrow material for beach nourishment projects. In the last few years, the potential for exploitation of these resources has rapidly grown with identification of suitable sand resource areas in some OCS regions. At the same time, the demand for high quality sand suitable for beach nourishment, coastal protection, and other public and private projects is anticipated to increase during coming years (Hammer et al 2004). However, the SAFMC is concerned that excavation of the offshore shoals could have significant adverse consequences to the shoreline and living marine resources.

Potential Threats to EFH from Offshore Sand and Mineral Mining

Potential threats include: removal of substrates that provide habitat for fish and invertebrates; creation (or conversion) of habitats to less productive or uninhabitable sites such as anoxic holes or silt bottom; burial of productive habitats in the vicinity of the mine site or in nearshore disposal sites (as in beach nourishment); release of harmful or toxic materials either with actual mining, or in connection with machinery and materials used for mining; creation of harmful turbidity levels; and modification of hydrologic conditions that cause erosion of desirable habitats.

Offshore mining of sand for beach nourishment has steadily increased along the south Atlantic coast. Presently, sand mining and beach nourishment activities are performed along the entire South Atlantic coast from North Carolina to Florida. Major projects include those at Wrightsville Beach, North Carolina; Myrtle Beach and Folly Beach in South Carolina; and many of Florida's beaches such as Palm Beach, Boca Raton, Fort Lauderdale and Miami Beach. Large-scale beach nourishment has also been performed at Tybee Island in Georgia; however, the material for that project was obtained from the Savannah Harbor deepening project. In addition to the larger projects that can involve millions of cubic yards of material, a substantial number of smaller projects involving beach scraping and removal of nearshore and inlet sand deposits are performed annually. While most of the larger projects are publicly funded and performed by the COE, many of these smaller projects are paid for with local revenues and/or private funds.

Although some of the environmental effects of sand mining and beach nourishment are documented there is much that is not known or studied (National Research Council 1995). NMFS and the FWS began raising questions over related effects as long as twenty years ago. In North Carolina and South Carolina concern over nearshore populations of mole crab (*Emerita talpoida*) and donax (*Donax spp.*) was raised with several projects. Although frequently requested, no long term studies on impacts to these and other beach fauna were ever performed. The fate of these species, from a population perspective, is of concern since they are important food items for transitory and resident fishes (e.g., Florida pompano, kingfishes, and spot) that are of economic and recreational importance (Hackney et al., 1996). Limited studies performed by Reilly and Bellis (1978) showed significant reductions in occurrence and biomass of mole crabs and Donax at nourished beaches. Considering that many miles of southeastern beach front are now filled and/or subjected to scraping and sand relocation each year the cumulative effect of this activity could be substantial. Reviews of numerous beach nourishment projects suggest that the overall infaunal communities recover relatively rapidly (months to < 1yr) although some species may remain adversely affected (NRC, 1995). Much depends on the compatibility of the material placed on the beach relative to what was present prior to the project.

In Florida, beach nourishment projects require the dredging and filling of millions of cubic yards of fine sediments among shallow cross-shelf habitats, repetition or these activities at 3-10 year intervals, and tens of millions of dollars in annual expenditures (ACOE, 1996). A U.S. Fish and Wildlife report (2004) prepared pursuant to Resolution 4 from the 8th Coral Reef Task Force meeting held on October 2-3, 2002, in San Juan, Puerto Rico, concluded that projects involving filling and dredging for beach nourishment and port development have caused the most impacts to coral reef habitats in South Florida since 1985. Among mid-shelf sand plains, often having nearby reef habitats, dredges create large craters and increased turbidity. At both dredge and fill sites, acres of shallow water hard bottom, worm reef, seagrass, or other habitats can be directly buried or subjected to elevated turbidity. Nearshore reefs buried or indirectly affected by dredging in south and central Florida can be utilized by over 325 invertebrate species (Nelson, 1989), 190 fish species, and serve as nursery habitats for many managed species (Lindeman et al., 2000). The timing of burial and anthropogenic turbidity spikes may have important effects upon the recruitment of settlement-stage fishes and invertebrates. Early spring through early fall dredge related burial of hard bottom may eliminate habitat required by larvae of many marine organisms during peak recruitment periods (Hackney et al., 1996, Lindeman and Snyder, 1999).

Based primarily on summary tabulations of data for southeast Florida within ACOE (1996), Lindeman (1997) estimates that:

- At least 47 large-scale offshore dredge and inshore fill projects have occurred since 1960.
- Approximately 97 additional large-scale dredge projects are conservatively planned to occur between 1997 and 2046.
- Over 48,000,000 cubic yards of offshore sediments have been dumped within an intertidal/subtidal corridor of approximately 500 feet x 110 miles in the last 36 years.
- Over 80,000,000 additional cubic yards of excavated offshore material may be dumped within the same corridor of subtropical southeast Florida in the next 50 years.

Long-term estimates of mean turbidity values under natural conditions are not available for most areas. Therefore, the percentages of affected animals and algae that can tolerate repetitious (e.g. 2 to 4 hours to 4 to 6 times a day for three months) sedimentation and elevated turbidity events (that may approximate continuous three-month storms), are unknown. With exception of hurricanes, highly turbid nearshore conditions in southeast Florida are typically the product of winter storms and heavy runoff during the rainy season. Near Miami, Florida turbidity in the nearshore hard bottom habitat is highly variable, and affected by winds, longshore currents, swell condition and upland runoff. Summer-fall months normally show lower turbidity level (1-4 NTUs [Nephelometric Turbidity Units] and winter-spring months show higher average levels (3-7 NTUs) (Miami-Dade DERM unpublished). Direct effects of dredging activities on corals have been discussed by Marszalek (1981), Goldberg (1988) and Blair et al. (1990). Although sublethal effects of elevated turbidity are poorly known in tropical marine environments, some information is available. Bak (1978) showed that a relatively short period of dredge-induced turbidity stress created an abrupt decrease in growth in two species of hard corals (*Agaricia* and *Madracis*). From both the magnitude and duration of suppressed calcification, he concluded that such metabolic shock may have long-term consequences on reproduction. Long-term resuspension of bottom sediments has been shown to adversely affect an important hard coral, *Montastrea annularis* (Dodge et al., 1974). Teleniski and Goldberg (1995a; 1995b) have recently demonstrated negative effects of sediment loads on hard corals at turbidity levels of approximately 18 NTUs. This is noteworthy, as the Florida state administrative threshold for temporary shut-downs of dredge operations is substantially higher (29 NTUs). Such work is needed for other taxa and would provide a scientific basis for maximum turbidity thresholds (Goldberg, 1988; Teleniski and Goldberg, 1995b). Herrnkind et al. (1988) demonstrated that increased siltation can cause direct loss of critical habitat for spiny lobster recruitment. Enhanced resuspension of sediments over time and chronic turbidity may lower key growth and reproduction rates of some algal and invertebrate populations which are a basis for primary and secondary production on an ecosystem scale (Lindeman, 1997b). The potential for management decisions to multiply over time and impact unintentionally large spatial scales is of concern (Odum, 1982; Rothschild et al., 1994) and is particularly relevant when affected species are also over harvested (Ault et al., in press).

Adopting 15 NTU above background as a threshold level for turbidity in Florida and other areas where waters are naturally not turbid is supported by sound science and appropriate for the following additional reasons:

1. Research associated with investigations by Telesnicki and Goldberg (1995) examined the effects of turbidity measured as an absolute value. In southeast Florida, turbidity standards are based on relative conditions (i.e., above background conditions);
2. We do not have adequate statistical competency to conclude that turbidity monitoring stations would be positioned in a manner that would capture the densest portion of the turbidity plume. Inherent risks associated with this warrant adoption of a more conservative threshold level; and
3. Although elevated turbidity levels may not directly or instantaneously kill corals, construction-induced turbidity may have long-term adverse impacts on corals (e.g., reduced reproductive health) that cannot be detected without carefully designed long-term monitoring.

In other areas of the Southeast where waters are more naturally turbid and sensitive bottom fauna such as reef habitat are not present, a higher NTU criteria may be desired. For example, the South Carolina Department of Health and Environmental Control has adopted a threshold of 25 NTU for impaired versus non-impaired estuarine and marine waters. While monitoring of turbidity plumes associated with beach nourishment operations in South Carolina have been limited, Van Dolah et al. (1994) monitored sediment plumes associated with a beach nourishment operation on Folly Beach, South Carolina to determine the both the amount and extent of turbidity. During calm seas, values of about 100NTU were measured in the surf zone at the pipeline outfall. Turbidity levels dropped to < 50 NTU in the upcurrent direction over a fairly short distance (<200 m), and more slowly in the downcurrent direction500-1000 m. Under more turbulent conditions of strong winds and rough seas, turbidity levels increased to over 200 NTU directly in front of the pipeline and higher turbidities were documented over a larger extent of the beach. However, turbidities in South Carolina's surf zone are naturally turbid, and turbidity values of about 100NTU were occasionally recorded at a reference beach in the Folly Beach study.

In addition, resource management agencies are examining the value of integrating Acoustic Current Doppler Current Profile (ADCP) technology into water quality monitoring protocols. ADCP is an instrument with capability of collecting acoustic backscatter data through the full depth of the water column and has demonstrated utility in other projects, especially in areas that are characterized by shifting currents (e.g., a project in Long Island Sound in which ADCP was utilized in the turbidity monitoring program in order to accurately locate the plume so that targeted water column sampling could be accomplished). We note that the nature of a plume in open water can be highly variable both spatially and temporally and can be further complicated by winds and seas. Therefore, to overcome these challenges and position the monitoring in the right place at the right time, full depth profiling with ADCP may be essential to the integrity of the monitoring performed. Use of third party environmental inspectors for water quality monitoring has also been included in recent large scale offshore construction project Corps of Engineers permits.

The SAFMC is concerned that excavation of the offshore shoals could have significant adverse consequences to the shoreline and living marine resources. Between 1995 and 2006, the U.S. Marine Minerals Service (MMS) provided approximately 14 million cubic yards of material from the Outer Continental Shelf (OCS) for 9 coastal projects in Florida (8) and South Carolina (1). Although many offshore shoals have not been thoroughly studied with respect to fish utilization, SAFMC believes the shoals serve as a benthic nursery area, refuge, and feeding ground for a variety of fishery resources. The SAFMC identifies sandy shoals as EFH for migratory pelagic fish, including king mackerel, Spanish mackerel, cobia, and dolphin. Clarke et al. (1988) and Michel et al. (2001) note the geomorphology of offshore shoals provide a unique assembly of micro-habitats that facilitate high biological productivity.

The MMS and Corps of Engineers are evaluating the St. Lucie Shoal (located offshore St. Lucie and Martin Counties, Florida) as a potential excavation site for beach renourishment in Dade and St. Lucie Counties. Anecdotal evidence suggests that the shoal is biologically unique and diverse, supporting fisheries that are economically and recreationally important, such as the migratory species listed above, sailfish, and prey species consumed by these fishery species.

In South Carolina, a survey of multiple sites dredged for beach nourishment purposes identified that most sites were slow to refill (average of 7 yrs among 5 sites) and generally refilled with non-beach compatible material (Van Dolah et al., 1998).

The SAFMC is concerned that mining shoals for sand may alter the local wave climate bringing about erosion that could affect EFH. Through an evaluation of the potential impacts from dredging linear shoals in the U.S. Gulf and Atlantic continental shelves, Hayes and Nairn (2004) concluded that the deflation of a shoal feature could change wave patterns between the shoal and the shoreline. In turn, such dredging could change longshore and cross-shore sand-transport patterns and erosion and accretion rates along the shore. Kelley et al. (2004) verified this conclusion in their examination of a borrow site offshore Martin County (depths were approximately 8 to 10 m), and recommend application of wave transformation numerical modeling tools that recognize the random nature of incident waves as they propagate onshore when examining incremental and cumulative changes from sand dredging on the continental shelf.

Furthermore, the SAFMC is concerned that excavation of nearshore borrow areas in addition to the placement of fill in nearshore areas could adversely affect hardbottom reefs in the area that are known to support corals and worm reefs colonized by *Phragmatopoma lapidosa*. Nearshore hardbottoms and worm reefs are also identified as EFH and HAPC by the SAFMC. These reefs reduce wave energy and stabilize shorelines (Kirtley 1967; Kirtley and Tanner 1968) and provide structural habitat for hundreds of fishery organisms (Gore et al 1977; Nelson 1989; Lindeman and Snyder 1999). Avoidance and minimization of impacts to hardbottom resources is needed. Due to the importance of these concerns, SAFMC recommends that MMS and the COE continue to coordinate closely with the NMFS Habitat Conservation Division to ensure the EFH assessments and NEPA documents contain sufficient detail to support federal decision making.

Other offshore mineral and mining does not presently occur along the south Atlantic coast. Extensive phosphate deposits have been located in Onslow Bay in North Carolina and large quantities of mineral nodules containing manganese and other metals are abundant along the continental shelf floor. It is reasonable to conclude that mining of these and other materials could become economically feasible. If initiated, mining of marine bottoms would cause substantial bottom disturbance that could impact productive hard bottom communities, shellfish beds, and wintering grounds for demersal fish. Since related port and processing facilities do not presently exist, new mooring and dockside facilities would be needed and related secondary impacts would be expected. These impacts are discussed in detail in Section 4.1.1.6 of this document.

6.1.2.5 Oil and Gas Exploration, Development, and Transportation

Extensive areas of the south Atlantic have been designated and blocked off for oil and gas development. Prior to 2003, this activity had been relatively dormant, unlike the pipelines and liquefied natural gas (LNG) facilities that proliferate in the Gulf of Mexico. Initial exploration in the vicinity of Cape Hatteras several years ago did not advance due to environmental and other concerns including consistency issues associated with North Carolina's Coastal Zone Management Program. As of this writing, interest in the potential for renewed oil and gas exploration off North Carolina is again being considered. Environmental Impact Statements have been prepared for Mid-Atlantic Sale

121 and South Atlantic Sale for the exploration of oil and gas offshore of Cape Hatteras, North Carolina. Should gas or oil be found, the laying of pipe to North Carolina's shoreline facilities would likely have to traverse barrier islands and associated wetlands. As oil and gas levels decline, exploration will undoubtedly resume and if economically viable reserves are located, this activity could expand and inshore and offshore EFH could be at risk.

There are currently three natural gas pipeline proposals in Florida that propose to construct pipelines from the Bahamas to southeast Florida. Between 1996 and 2006, NMFS reviewed 548 applications and support documents associated with pipelines in the South Atlantic area. The NMFS Southeast Region Habitat Conservation Division (HCD) office is engaged in three separate EFH consultations for natural gas pipeline projects proposed to be constructed from southeast Florida to the Bahamas. One of three projects (AES Ocean Express) has received Department of the Army (DA) authorization and a Federal Energy Regulatory Commission (FERC) license to proceed with construction. However, to our knowledge, all of these projects are still awaiting the necessary approvals from the Bahamian government.

One pipeline company (Calypso), recently filed an application with the U.S. Coast Guard to construct a deepwater port located approximately 5 to 10 off the eastern coast of Florida to the northeast of Port Everglades in a water depth of approximately 640 to 950 feet.

<u>Potential Threats to EFH from Oil and Gas Exploration, Development, and Transportation</u>

Potential threats include elimination or damage to bottom habitat due to drill holes and positioning of structures such as drilling platforms, pipelines, anchors, etc., water intake and impacts to ichthyoplankton, release of harmful and toxic substances form extracted muds, oil, and, gas and from materials used in oil and gas recovery; discharges of potentially large volumes of drilling fluids (muds) used during the well drilling process and produced (brine) water from the extraction phase; damage to organisms and habitats due to accidental spills; damage to fishing gear due to entanglement with structures and debris; and damage to fishery resources and habitats including deep water habitats, due to anchoring and effects of blasting (used in platform support removal); and indirect and secondary impacts to nearshore aquatic environments affected by product receiving, processing, and distribution facilities.

The various threats to EFH that would result from natural gas pipeline installation and construction depend on project location and construction methods proposed. Horizontal directional drilling was one of the primary nearshore construction methods evaluated, but eventually ruled out due to concerns that pertain to frac-outs, which are generally caused when the drill head moves through an area of unconsolidated sediments. Frac-outs are typically monitored through monitoring the hydrostatic pressure differential. Considering that frac-outs can occur anywhere along or near the pipeline route, pressure monitoring alone was not sufficient in areas that support reef. Frac-outs can occur as a slight release of mud or an uncontrolled flow of drilling muds.

According to Stauber et al., (2003) with sufficient geotechnical information it is possible to calculate a maximum allowable borehole pressure curve for a given HDD bore profile. Using this information, preliminary bore plans could be developed that provide reasonable assurance that the bore could be completed without incident. Therefore, SAFMC recommends that pipeline applications include an HDD Risk Analysis to ensure that the bore paths identified are the least likely to contribute to a frac-out.

Other threats to EFH could occur as a result of offshore dredging of exit pits and direct burial of resources through the pipeline placement, movement, and/or articulated concrete mats which are typically proposed for use in water depths of less than 200 feet for pipeline stabilization. In addition, drilling muds and the use of additives, such as Envis (a mixed metal hydroxide) or StaFlo (a polyanionic cellulose) are commonly used during drilling operations to control drilling mud flow and fluid loss. Another potential threat is hydrostatic testing which is typically proposed to verify that the pipeline was properly installed and structurally sound. Chemicals may be proposed for use in hydrostatic testing and can include corrosion inhibitors, biocides, oxygen scavengers, and leak detection dye that would be used for pipe treatment and as seawater additives.

Another nearshore construction approach involves tunneling, which is preferred over HDD but has not been tested yet in nearshore areas of southeast Florida. Tunneling poses less risk to the marine environment because it may be possible to conduct operations independent of weather and it reduces or eliminates the risk of frac-outs because the operation is conducted under much less pressure and at greater depths. However other issues are still being evaluated, such as the potential for localized slumping or heave, tunnel failure, a higher probability of a frac-out near the tunnel exit location, and hydrostatic testing, as mentioned above.

To date, only one deepwater LNG port has been proposed in the South Atlantic. However, the Federal Energy Regulatory Commission has received three applications (including Calypso) to construct pipelines from southeast Florida to the Bahamas. To date, none of the applications has received approval from the Bahamian government to construct regassification facilities. Therefore, SAFMC is concerned about the potential for multiple deepwater ports to be proposed offshore southeast and east-central Florida. The September 2006 Calypso application states that approximately 273 acres of deepwater habitats could be impacted as a result of anchoring activities. Benthic organisms may be adversely affected from direct crushing and disturbance of sediments in the immediate vicinity of the anchors. The Calypso LNG terminal is proposed to be located on or adjacent to the Miami Terrace, which is a proposed deepwater coral HAPC. Hardbottom and coral resources found along the Miami Terrace and Escarpment are identified as EFH and HAPC by the SAFMC. Reed et al. (2006) characterized the fauna on the Miami Terrace and Escarpment as consisting of gorgonacean octocorals, colonial scleractinian corals (including thickets of *Lophelia pertusa*, *Madrepora oculata*, and *Enallopsammia profunda*), stylasterine hydrocorals, and Antipatharia. Diverse populations of the sponges Hexactinellida and Demospongia also occur along the Miami Terrace and Escarpment. In addition, based on studies conducted for the Calypso

Pipeline Final Environmental Impact Statement, side-scan sonar results from the area show highly reflective signatures, which suggests the substrate is hardbottom mixed with medium carbonate sands and silty sands.

Unlike the open loop LNG facilities proposed and in operation in the Gulf of Mexico, the Calypso LNG facility is proposed to be a closed loop system (it should be noted, however, that Calypso could have chosen to use open loop regassification technologies and, given cost considerations, so might any other LNG company that looks at the Atlantic coast off Florida). Open loop systems use seawater for the regasification of LNG and water intakes can exceed 100 million gallons of water per day. However water intake associated with closed loop systems is only for engine cooling and can range from approximately 30-60 million gallons per day depending on the number, type, and duration of vessels at Port. With the closed loop system proposed in the South Atlantic, the discharge water would be approximately 13 degrees Fahrenheit warmer than the intake water.

Applications for LNG facilities should adequately consider potential impacts to fishery resources and the project's proximity to the Gulf Stream. The conditions and flow of the Gulf Stream are variable on time scales ranging from two days to entire seasons. Important spawning locations can occur along the Gulf Stream front (e.g., *Coryphaena*, *Xiphius*) (SAFMC 1998). Movement of the Gulf Stream front also affects the distribution of adult fishes (Magnuson et al. 1981); hook-and-line fishermen and longliners target much of their fishing effort in these frontal zones.

Biological and economic analyses of impacts related to impingement and entrainment of the various life stage histories of fishery resources are needed to allow the SAFMC, public, and NOAA to assess the costs of lost fisheries production from the water intake/discharge component of the Calypso LNG deepwater port. Such examinations should include detailed comparisons of the environmental impacts and environmental costs of alternative closed-loop regasification technologies to understand more fully the potential impacts to fishery resources. Analyses should be based on an assumption of 100% zooplankton mortality that would result from water intake, unless the applicant can show applicable studies demonstrating otherwise. In addition, surveys of the ichthyoplankton communities within project areas are needed because in many areas, including water off Fort Lauderdale, there are no site-specific data regarding ichthyoplankton resources. Such surveys should be designed to provide a quantitative assessment of the impacts to fishery resources. In addition, the surveys should be designed to support the monitoring of impacts from port operations on fishery resources so that adjustments to those operations can be made in a timely manner.
Although the continental shelf of the South Atlantic Bight has been the focus of moderate interest for exploration of oil and gas resources, there are presently no ongoing related activities in the region with exception of that mentioned above.

In addition to what is presented above and considering the current status of the industry, a brief overview of the facilities that might be emplaced on the Outer Continental Shelf (OCS) to facilitate oil and gas exploration, development, and production is also presented. This includes drilling vessels (jack-ups, semi-submersibles, and drill ships), production platforms, offshore moored terminals, and pipelines.

Oil and gas related activities are inherently intrusive and pose a considerable level of threat to marine and estuarine ecosystems, including EFH. As discussed below, exploration and recovery operations may cause substantial localized bottom disturbance. Where large scale development is undertaken the area of impact may be greatly expanded and become regional in scale. The toxic nature of hydrocarbon products and certain drilling materials (e.g., drilling muds), spill clean up chemicals, and the large volume of unrefined and refined products that must be moved within the coastal zone places large areas and resource bases as risk.

Structure emplacement can be expected to disturb some bottom area and, if anchors are deployed, the area of disturbance could be expanded. Jack-up rigs and semi-submersibles are generally used in water depths not exceeding 400 meters and disturb about 1.5 ha (3.7 ac) of bottom each. Conventional fixed platforms are also employed where water depths are less than 400 meters and they disturb about 2 ha (4.9 ac). Where water depths exceed 400 meters, dynamically-positioned drill ships may be used and sea floor disturbance is usually limited to the well site. Tension leg platforms may also be employed at these depths and the potential bottom disturbance area associated with these structures is about 5 ha (10.25 ac).

Each exploration rig, platform, terminal, and pipeline emplacement on the OCS can be expected to disturb surrounding areas. Exploration rigs, platforms, and pipe laying barges use an array of eight 9,000 kg anchors to position a rig and barge, and to move the barge along the pipeline route. These anchors are continually moved as the pipe laying operation proceeds and the total area actually affected by the anchors will depend on water depth, wind, currents, anchor chain length, and the size of the anchors and chain (MMS 1996). With conventional, fixed multi-leg platforms, which are anchored to the sea floor by steel pilings, explosives are generally used to sever conductors and pilings. These support structures are substantial in size since they must withstand hurricane conditions and have an average lifespan of about 20 years. The Minerals Management Service requires severing support structures at five meters below the sea floor surface so as to preclude interference with commercial fishing operations.

Possible injury to biota from use of explosives extends horizontally to 900 meters from the detonation site, and vertically to the surface. Based on MMS data, it is assumed that approximately 80 percent of removals of conventional fixed platforms in the Gulf of Mexico, in water less than 400 meters in depth, will be performed with explosives (MMS 1996). Alternative methodologies such as mechanical cutting and inside burning are often ineffective and are hazardous to workers.

Associated bottom debris commonly associated with over water oil and gas operations includes cable, tools, pipe, drums, assorted trash, and structural parts of platforms. The amount of bottom debris deposited around a site may vary and may be measured in tons. Extensive analysis of remotely-sensed data within developed lease blocks indicates that the majority of ferromagnetic bottom debris falls within a 450 meter radius of the site. The Fisherman's Contingency Fund, which was established by the oil and gas industry, provides recourse to commercial fishing interests for recovery of equipment losses due to shrimp net entanglement (MMS 1996).

Blowouts occur when improperly balanced well pressures result in sudden, uncontrolled releases of petroleum hydrocarbons. Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, or workover operations. About 23 percent of all blowouts will have associated oil spills, of which eight percent will result in oil spills greater than 50 barrels, and four percent will result in spills greater than 1000 barrels. In subsurface blowouts, sediment will be resuspended and bottom disturbance will generally occur within a 300 meter radius. Whereas larger grain sediment will settle first, fined grained material may remain in suspension for periods of up to thirty days or longer. Fine grained material may be redistributed over a significantly large area depending on the volume of sediment disturbed, bottom morphology, and currents (MMS 1996).

The major operational wastes associated with offshore oil and gas exploration and development include drilling fluids and cuttings, and produced waters. Other important wastes include: from drilling--waste chemicals, fracturing and acidifying fluids, and well completion and workover fluids; from production--produced sand, deck drainage, and miscellaneous well fluids; and from other sources--sanitary and domestic wastes, gas and oil processing wastes, ballast water, storage displacement water, and miscellaneous minor discharges (MMS 1996). Major contaminants or chemical properties of materials used in oil and gas operations may include those that are highly saline; have a low ph.; contain suspended solids, heavy metals, crude oil compounds, organic acids, priority pollutants, and radionuclides; and those which generate high biological and chemical oxygen demands. Pierce et al. (1980) documented that wild fish have been injured by petroleum pollutants. Grizzle (1983) suggested that larger liver weights in fish collected in the vicinity of production platforms versus control reefs could have been caused by increased toxicant levels near the platforms. He also suspected that severe gill lamella epithelium hyperplasia and edema in red snapper, vermilion snapper, wenchman, sash flounder, and creole fish were caused by toxicants near the platforms. These types of lesions are consistent with toxicosis.

Accidental discharge of oil can occur during almost any stage of exploration, development, or production on the OCS or in near shore base areas. Oil spills may result from many possible causes including equipment malfunction, ship collisions, pipeline breaks, human error, or severe storms. Oil spills may also be attributed to support activities associated with product recovery and transportation. In addition to crude oil spills, chemical, diesel, and other oil-product spills can occur with OCS activities. Of the various potential OCS-related spill sources, the great majority are associated with product transportation activities (MMS 1996).

As of this writing, only test wells have been drilled in the South Atlantic Bight area and these have been confined to inshore areas. All of these wells were capped immediately after drilling. No production or transportation facilities such as offshore terminals and pipelines have been built, nor are any such facilities currently planned in South Atlantic Bight waters. Despite this, millions of barrels of crude oil and refined product transit South Atlantic Bight waters by tank vessel every year and the potential exists for the discharge of thousands of barrels of oil due to vessel collision or sinking. Discharge of untreated ballast water from transiting vessels is also a chronic low level source of petroleum-based pollution.

6.1.2.6 Commercial and Industrial Activities

Direct physical encroachment into offshore environments by industrial activities is relatively limited along the south Atlantic seaboard. Notable exceptions include thermal intake and outfall structures associated with power plants in North Carolina and Florida, and sea walls that are used to protect commercial and industrial development. Several municipal sewage outfalls which discharge commercial and possibly light industrial wastes also exist. Although direct physical impacts may be minor on a regional scale, water quality effects are largely unknown. Indirect effects, such as those associated with point and nonpoint-source discharges are thought to be substantially greater since it has been shown that discharges, including trash and debris, from land based activities may reach coastal waters and food webs.

Commercial development for hotels, motels, and related infrastructure along the south Atlantic shoreline has been extensive. Because many of these developments are located on unstable and shifting coastlines, maintaining associated buildings, revetments, bridges, causeways, beaches etc. has, and will continue to have an adverse effect on nearshore and offshore processes and environments.

<u>Potential Threats to EFH from Commercial and Industrial Activities</u>
Potential threats include: direct and/or non-point-source discharge of chemicals, placement of intake structures, and protective sea walls (often used in connection with commercial establishments), and cumulative and synergistic effects caused by these and other industrial and non-industrial related activities.

Future exploration and recovery of marine resources and placement of offshore mooring and unloading facilities could substantially threaten offshore EFHs. Although none of these activities or facilities are presently being planned, it is likely that continued economic growth, depletion of limited natural resources, and use of limited coastal lands will eventually lead to greater exploitation of offshore resources.

Electric power generation is needed for commercial and industrial development, and for residential purposes (See Section 4.1.1.4). Between 1996 and 2006, NMFS evaluated 85 proposals to construct new or expand existing electric generation facilities. When located in coastal waters, power generation facilities may adversely affect EFH and associated biota. Potential threats include direct displacement of wetlands, submerged bottoms, and vegetated upland buffer areas for generation facilities and ancillary uses such as fossil fuel storage, cooling towers, and water intake and outfall structures; construction of navigation channels and docks for unloading coal, oil, and other materials needed for operation of generators and equipment; discharge of toxic substances from air emissions; cooling waters (e.g., chlorine); and from point and nonpoint-source discharges emanating from impervious surfaces and coal and slag piles; discharge of thermal discharges that may be lethal to flora and fauna, or that serve as attractants that subject fish, invertebrates, and marine mammals to thermal stress when changes in plant operation or weather occur; and entrainment and impingement of living marine resources in which organisms succumb to or are damaged as a result of entrapment in intake structures or capture on screens.

An example of an electric power generation plant and threats to EFH is the Florida Power and Light's Turkey Point Power Plant, located along Biscayne Bay in Dade County Florida, which directly impacted over 24 acres of estuarine emergent wetlands, including mangrove wetlands, seagrass, and open water habitat in order to construct a natural gas-fired electric generating facility to provide electricity to meet the projected 2007 demand in southeast Florida. An additional 10.7 acres of wetlands were impacted through secondary effects. The wetlands at the subject site are high quality, uncommon, and provide direct benefits to the fishery resources of Biscayne Bay. The bays extensive seagrass beds, mangrove wetlands, and hardbottom communities support a diverse array of fishes and invertebrates including over 512 species of fishes and over 800 species of invertebrates which have widely variable environmental requirements for growth and reproduction.

Although relatively minor in its present scale, the commercial harvest of *Sargassum* from coastal waters off North Carolina is of concern. *Sargassum* weed lines and associated frontal zones provide cover, trophic, and other attributes needed to sustain endemic fish and invertebrates of the pelagic *Sargassum* community and associated fauna. The weed lines may be especially important during early life stages of sea turtles and certain fish and they are important sites for the North Carolina and South Carolina offshore recreational fishery.

The occurrence of methyl mercury in the flesh of the large piscivorous fish such as king and Spanish mackerel and other large pelagic and demersal species such as amberjack, wahoo, snapper, and grouper has been documented and is of concern largely with respect to human consumption of these species (D. Engel, personal communication). The probable source of these contaminants is atmospheric input from worldwide inventories associated with emissions from incinerators, fossil fueled power plants, automobiles, and industry. As such, the regulation of surface water contamination from atmospheric pollution may require local, regional, and international efforts.

Effects related to commercial development are similar to those from urban and suburban development and the discussions in Section 4.1.1.4 apply. Further, effects of shoreline modifications such as beach nourishment are found in Section 4.1.2.3.

6.1.2.7 Artificial Reefs

Artificial reef construction in the South Atlantic has substantially increased over the last 10 years. Project scales range from single family homeowners applying to place reef balls under docks for lobster recruitment to 3,000 acre areas located in offshore areas. Project applications typically state that the purpose of the project is to “further develop three artificial reef sites to increase the marine flora and fauna within the area for local fishermen and SCUBA divers without detriment to the existing reef structures or fish populations.” However, artificial reefs are also constructed to replace natural reef habitats. Construction at the larger scale sited typically involves the placement of a variety of materials including concrete, limestone boulders, submerged vessels, and other approved items.

<u>Potential Threats to EFH from Artificial Reefs</u>

Potential threats to EFH include permanent conversion of one habitat type to another, introduction of predators, possible increased fishing activity and relic gear on structures.

Although the SAFMC recognizes and appreciates applicant’s efforts to provide additional marine habitat, information regarding the level of impact this project would have on EFH resources is needed in the application process. This information need includes a thorough assessment of environmental impacts and details concerning its design and specifications. The type of information that should be contained in an artificial reef application includes:

- It should be demonstrated that the project will provide enhanced marine fisheries habitat. This may be achieved through (but not limited to):
    - Identifying the specific fisheries and life history stages that will be enhanced by the proposed work.
    - Demonstrating a clear link between the structural design and the fisheries the artificial reef will support.

- The applicant should demonstrate full consistency with NOAA’s *National Artificial Reef Plan* (1985) and the draft plan revision (2001)[1], including, but not limited to, the following provisions:
    - Demonstrated consistency with the applicable state’s artificial reef plan (e.g., the State of Florida’s Artificial Reef Plan). Through this, the applicant should:
    - Have a specific objective for fisheries management or other purpose stated in the goal of the statewide, or site-specific plan;
    - Have biological justification relating to present and future fishery management needs;
    - Have minimal negative effects on existing fisheries, and/or conflicts with other uses;
    - Have minimal negative effects on other natural resources and their future use;
    - Use materials that have long-term compatibility with the aquatic environment;

[1] National Artificial Reef Plan (revised 2001). National Marine Fisheries Service. Available on-line at: http://www.nmfs.noaa.gov/irf/Revised_PLAN_11_16.pdf

  - Conduct monitoring during and after construction to determine whether the reef meets permit terms and conditions and is functioning as anticipated.
- The applicant should ensure that the proposed artificial reef structure will not threaten the integrity of natural habitats in the area, including live/hardbottoms, corals, seagrasses, and macroalgae;
- The application should verify that any vessels deployed have been cleaned in accordance with Environmental Protection Agency Guidelines;
- The constructed reef should remain stable during a 100-year storm event;
- The applicant should identify the most extreme sea state and wave surge conditions under which work will be undertaken; and
- An entity should be identified to demonstrate the capability of assuming long-term financial liability for the deployment, biological and stability monitoring, and maintenance of the artificial reef.

Artificial reefs can serve as effective fishery management tools (when coupled with additional fishery management measures, for example the designation of no-take zones) to attract fish and, in some situations, mitigate for anthropogenic and natural damage to coral and hardbottom reefs. The SAFMC concurs with the leading artificial reef researchers in this region (see Bohnsack 1989) that artificial reefs are unlikely to benefit heavily exploited or overfished populations without other management actions. Conversely, if not properly sited they may have only minimal habitat value and could even degrade existing reef resources if placed on or in close proximity to such habitats. Artificial reefs are also constructed as mitigation reefs. A U.S. Fish and Wildlife report (2004) prepared pursuant to Resolution 4 from the 8th Coral Reef Task Force meeting held on October 2-3, 2002, in San Juan, Puerto Rico, concluded that projects involving filling and dredging for beach nourishment and port development have caused the most impacts to coral reef habitats in South Florida since 1985. The 26 Florida projects (16 completed; 10 pending) reviewed in this report impacted 217 acres of reef, and mitigated with 113 acres of artificial reef. However, a study is needed that would provide information as to impacts to hard bottom communities of shoreline projects, including whether proposed mitigations are adequate to offset the environmental impacts of the activities. General practice in Florida is to permit mitigation for shallow hard bottom communities in deeper waters is contributing to a substantial net loss of the shallow communities and related functions.

6.1.2.8 Alternative Energy Technologies

Sections below excerpted from MMS Alternative Energy Synthesis report: Michel, J., Dunagan, H., Boring, C., Healy, E., Evans, W., Dean, J.M., McGillis, A. and Hain, J. 2007. Worldwide Synthesis and Analysis of Existing Information Regarding Environmental Effects of Alternative Energy Uses on the Outer Continental Shelf. U.S. Department of the Interior, Minerals Management Service, Herndon, VA, MMS OCS Report 2007-038. 254 pp. See Report for references in following sections.

Offshore wind turbines

An offshore wind farm is a set of turbines that generate electricity from the mechanical force that the wind imparts upon an object and are specifically designed for their oceanic location. Each modern oceanic turbine is capable of producing up to 4.5 megawatts of power (some older turbines installed in the 1990s produced less than 1 megawatt, newer turbines under development may produce 5 to 10 megawatts), and the hub of the turbine is 180 feet or more above the sea surface. Present proposals include systems with blades that will reach more than 510 feet above the sea surface. The number of turbines in a farm varies and will be affected by economics, space, and demand for the electricity generated. The number of turbines in proposed farms ranges from three units in a proposed research setting to over 150. The turbines need to be separated from each other by a distance of 0.25 mile or more in order to reduce the effect one turbine has upon the wind field experienced by adjacent turbines. Wind farms include a distribution platform that serves as a hub for the cables that collect power from each turbine and the fewer, but larger, cables that carry the power to shore.

A recent study conducted by the Minerals Management Service (MMS 2007) cites the following as the current primary economic and technical feasibility determinants that affect the choice of sites for offshore wind parks:

- Availability of a substantial, relatively constant wind resource
- Shallow water (less than 30 meters deep)
- Proximity to an area of high electricity consumption
- Distance to shore

Water depth is a critical design element that currently limits installation in deeper waters because of technology and economic constraints. Existing wind parks in Europe are installed in very shallow water (up to 15 m deep). Most North American wind resources are in water greater than 30 m deep, requiring development of economically feasible new technologies for wind turbine structures that can withstand wave and wind action in deeper areas (MMS 2007).

In addition to the water depth limitations of technology as of 2007, significant economic concerns are associated with the distance from shore and the length of subsea electrical cable required to reach the onshore electrical grid. Although available wind turbine designs allow installation in waters less than 30 m deep, wind parks operating in Europe are in shallower coastal areas (water depths of approximately 15 m). In the United States, wind parks are likely to be developed along the Atlantic seaboard and the Gulf of Mexico (MMS 2007).

The Cape Wind project offshore of Massachusetts and the Long Island Offshore Wind Park (LIOWP) offshore New York are in the environmental impact statement (EIS) stage, and other projects are planned along the northern and central U.S. coast. In addition, two leases have been granted by the State of Texas to develop wind parks off the coastline of Padre Island and Galveston Island. Additional projects are in the early planning stages along the U.S. east coast and Gulf of Mexico (MMS 2007).

<u>Potential threats to EFH from Offshore Wind Turbines</u>

Operational characteristics of each turbine design and its size are influenced by the minimum sustained winds occurring in an area and needed to make the wind farm profitable. Studies from the northeastern U.S. conclude a minimum wind speed of 16 mph or more is needed, studies from the southeastern U.S. conclude wind speeds of 11 to 13 mph are sufficient (Stewart 2005). Analyses are not simple; wind persistence, direction and natural turbulence can limit a turbine's ability to produce electricity even though its blades are spinning. Analyses must also consider the efficiency of the turbines and the number of days in a year when the wind reaches or exceeds the minimum speed required to produce electricity. Other factors that influence the feasibility of establishing a wind farm include proximity to an established electrical grid and water depth, because market availability and water depth affect construction cost. Some authorities suggest 180 feet is a maximum depth; developers of the wind farm off Cape Cod, MA, actively sought waters less than 50 feet deep. Lloyd's Insurance has set 12 fathoms as their insurance risk limit. The occurrences of high winds are an issue since they can damage the turbine systems. Wind speeds that cause the blades to rotate above 14 revolutions per minute trigger most systems to shutdown.

In the United States, there are no offshore wind farms in operation, although six projects are currently being considered (Dennehey 2006, Ludwig 2006). Two are off the coast of Cape Cod, MA, two of the coast of Texas, one off the coast of Long Island, NY, and one is being considered off the Pacific Northwest Coast. Evaluations of the general environment off North Carolina and Georgia by universities conclude that wind farms warrant further investigation in these areas (Halks et al. 2005, Stewart 2005). Offshore wind farms have been established in Europe, especially in Denmark, and business forecasts indicate additional farms are likely due to tax and business incentives that focus on renewable energy (Danish Energy Authority 2005, see also http://home.planet.nl/~windsh/offshoreplans.html).

There are three general designs currently in use for anchoring turbines to the sea bottom, and the design chosen affects the extent of the environmental impacts (Danish Energy Authority 2005). A gravity foundation uses a large base (much broader than the pylon) with supplemental mass being placed on the base structure to anchor the pylon on the seafloor. A monopile base is a piling driven deep into the sea floor to create the stable anchor and is similar in diameter to the pylon itself; monopiles are currently used in water depths up to 60 feet. Multi-pole bases consist of piling systems similar to those used in small offshore oil and gas platforms; pilings are driven into the sea bottom over an area that is broader than the pylon that supports the turbine and the pylon is attached to a framework and platform that links the pilings. When commenting on a proposal by Cape Wind Associates for a wind farm on Nantucket Sound, MA, NOAA Fisheries indicated a preference for the 46-ft diameter, monopole design because it impacts less sea bottom and fishing gear is less likely to snag on this type of structure. Research being done in Europe is examining the feasibility of floating foundations and hybrids between monopile and gravity foundations that will allow farms to be located in deeper water without requiring a foundation that occupies a large amount of sea bottom. One of the wind farms proposed for New York plans to investigate the stability of a jack-up barge as its base, and the wind farms proposed for Texas are exploring use of oil and gas platforms that are no longer needed by the petroleum industry.

Long-term impacts to coastal ecosystems from wind farms are unclear because only a few offshore wind farms have existed for more than 10 years. However, all the wind farms recently constructed or authorized in Europe include substantial monitoring programs, so lack of data should not remain a problem for long. U.S. Army Corps of Engineers (2004) and the Danish Energy Authority (2005) provide initial lists and summaries of the impacts that can be expected from an offshore wind farm and the latter also provides Internet links to Web sites planned for distributing future study results.

Direct impacts to coastal ecosystems include usurpation of seafloor habitat(s) by the pilings, distribution platforms, and cables that connect the turbines to the onshore power grid. Especially when the monopile design is used, the cumulative area impacted is small; for example, Cape Winds Associates estimates the pylons from their farm of 130 turbines would occupy less than one acre of sea bottom. Construction equipment impacts during cable and system installations would add to this acreage. Direct effects to the sea bottom also may occur from alteration of current fields moving past the foundations, but these impacts to be manageable in most circumstances.

The most obvious affect of the pilings on marine biota will be from the structures serving as fish habitat. Many fish are attracted to any structure that provides relief from the otherwise featureless sea floor. Benthic organisms, which may adhere to a pylon or its base, depending on local conditions and construction materials, may add to the attractiveness of the structure to fish. Although unlikely to be an issue, there is some concern that electromagnetic fields (EMF) may disrupt the movements of sharks and other aquatic resources that navigate by sensing the earth's electromagnetic fields. Wind farms can transmit direct current, which has a greater capacity than alternating current to create localized EMF. Recent research indicates the severity of this impact may be small. Vibrations transmitted from the structures and systems to the water column and affecting the behavior of fish is a concern but not much is know about the severity of this impact. Monitoring in Europe has not found evidence of either EMF or vibration impacting aquatic resources (Ludwig 2006). Indirect impacts to marine biota may result from wind farms shifting navigation away from preferred routes into areas where marine mammals or fishery resources are more concentrated. The Federal Aviation Administration and military have recently identified that wind farms create a shadow effect on near ground, tracking radars.

Socioeconomic impacts have been controversial. Many members of the public object to the expected deteriorations in the vistas caused by the wind farms as well as wind farms occupying preferred fishing grounds. However, the Europeans have experienced a sharp increase in eco-tourism at their wind farm sites. The public also has been focused on impacts to seabirds, although impacts to birds seem uncommon based on preliminary evidence (Danish Energy Authority 2005).

Ocean current technology

(Excerpted from MMS 2007 report)
Ocean current technology is similar to wind technology, only underwater. Instead of wind, ocean current pushes turbine blades to transfer kinetic energy. Similar to wind turbines, the blades of the current turbines move at a very slow speed. For example, one type of design has vertical turbine rotors that rotate 10 to 30 revolutions per minute, which is approximately 10 times slower than ship propellers. Although the rotors move slowly, they produce a significant amount of energy because of the density of water moving them.

In the United States, no operating commercial systems using ocean current technology are connected to an electrical grid at this time (MMS, 2006). However, the technology to harness ocean current energy as an alternative energy source is in the developmental stage. Demonstration and pilot studies of different prototypes are taking place throughout the world. Marine current velocities are lower than those of wind, but because water is 835 times denser than air, a 3-knot current has the kinetic energy of 161 km/h wind. The total potential energy contained in marine currents worldwide is estimated at approximately 5,000 GW (MMS, 2006).

Available data indicate that current velocities between 2 and 5 meters per second (m/s) would be required to make ocean current energy technology economically viable at a particular site (MMS, 2006).

In the United States, the most promising sources of ocean current energy include the Florida Current (part of the Gulf Stream) and the California Current (MMS, 2006). These ocean current resources are located relatively close to shore and near centers of high electricity demand, making ocean current energy an attractive resource. In addition, ocean currents tend to be significantly more constant than wind resources, which can fluctuate greatly over relatively short periods of time.

A number of turbine designs exist, some of which have been through field testing while others are still in the development phase (MMS 2007). Florida Hydro is testing a disk-like design called the Open Center Turbine for use in the Florida Current (**Figure 6.1-1**).The moving parts of this technology are encased within the unit. Designed to produce 2.5 MW, the turbine was tested off Palm Beach, FL.

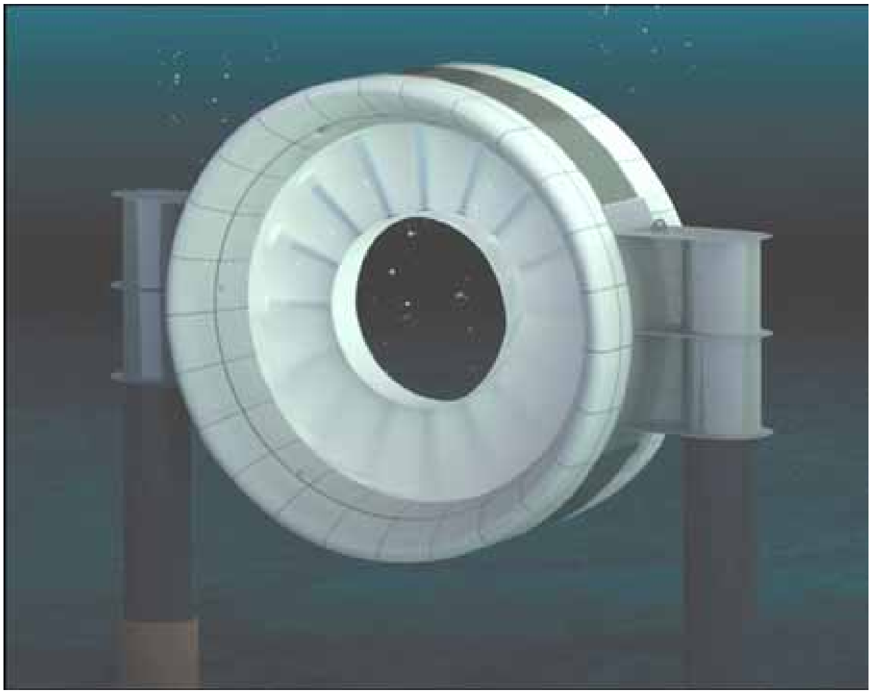

Figure 6.1-1. Open center current/tidal turbine with encased moving parts (Source: Open Hydro Group Limited).

Several other ocean current technologies are being developed. Those designs are tethered to the seabottom using anchors or on poles that extend from seabed foundations (ABP, 2004). These technologies are in the very early stages of development; however, they may be the most promising design for deeper, offshore applications on the OCS.

<u>Potential threats to EFH from Ocean Current Technology</u>
Need to develop

Solar technology

(Excerpted from MMS 2007 final report)
Solar energy technology has been producing useable energy from land-based, full-scale, grid connected power plants for more than a decade, but use of solar energy technology on the OCS is very limited. Economically feasible installation of full-scale solar energy projects on the OCS will depend on producing significant amounts of transmittable energy.

The possibilities for solar technology are not limited to large offshore solar plants; solar energy technology could be collocated with other alternative energy technologies. For example, solar collectors could be installed near the base of a wind turbine, and then used to augment energy output. Solar technology also could be installed as an alternative use for decommissioned oil and gas platforms on the OCS. Already some small, unmanned oil and gas platforms use solar panels for electricity needs. Solar panels are also used on buoys, platforms, and meteorological stations.

The potential for annual average solar power varies greatly by latitude and cloud cover; solar radiation is significantly greater in the lower latitudes. In the United States, solar radiation is greatest in southern parts of the country. A literature review yielded no information on solar radiation levels offshore and along the OCS (MMS, 2006). However, unpublished solar radiation data may exist as shipboard information collected during routine or research operations.

Solar energy is converted into useable energy through two basic technologies: thermal and photonic. Thermal technologies convert solar energy to heat. Photonic technologies absorb solar photons, which are then converted into electricity through photovoltaic (PV) cells. Technology is also in the early stages of development to store the photonic energy as hydrogen for later use, rather than convert it directly to electricity (MMS, 2006).

Some solar technologies use concentrating mechanisms to focus heat or photonic solar energy into a collector. Technology and application of concentrated PV are not as advanced as concentrated thermal technology, but it is under development. Concentrated PV and thermal systems use mirrors or lenses configured to concentrate solar radiation on receiving panels.

Current solar energy technology has limited application on the OCS. It is distributed only to power buoys, weather stations, and small, unmanned oil and gas platforms. A literature review revealed no solar energy projects on the OCS at any stage of planning or development. Any offshore solar energy project would need to be mounted onto some sort of large floating or fixed structure (MMS, 2006). The number of solar panels, and therefore, the size of the structure necessary to support an offshore commercial solar energy facility would vary depending on the solar radiation level at the location, the orientation of the panels, and weather conditions.

Thermal solar technologies require dry, warm locations, and thus, current technologies likely would not be feasible on the OCS where humidity is high. PV solar technology surface area requirements also limit their application at OCS locations, where a floating platform would be required. Approximately 8 to 12 square meters is required for each kilowatt of capacity, meaning 0.8 to 1.2 hectares (0.008 to 0.012 km^2) of PV cells would be required for each 1 MW of power output (MMS, 2006). Concentrated PV systems developed for thermal solar projects are in early development. Efficient concentrated PV technologies may increase the economic feasibility of OCS solar applications because PV is more effective in humid environments.

Hydrogen Technology

Hydrogen technology would be used on the OCS as a transport or storage mechanism for energy produced by one of the other alternative energy technologies (wind, wave, current or solar). No projects were identified at any stage of planning or implementation for this type of technology. The best source of information on the possibilities of using hydrogen technology for storage or transport of energy on the OCS is the MMS (2006) white paper. Since the application of hydrogen technology is so undefined at this stage, and because there are no current plans or prototypes for OCS application, the potential impacts were not included in the MMS report (2007).

6.1.2.9 Non-native or nuisance species

Indo-Pacific Lionfish

Lionfish (*Pterois volitans*/*miles* complex) are venomous coral reef fishes from the Indian and western Pacific oceans, that are now found in the western Atlantic Ocean (Whitfield et al. 2002, Hare and Whitfield 2003, Meister et al. 2005, Ruiz-Carus et al. 2006, Whitfield et al. 2006). Adult lionfish have been observed from the Turks and Caicos Islands throughout the northern Bahamas and from Florida to Cape Hatteras, North Carolina, including Bermuda. There is also recent evidence to suggest that lionfish have been found near Tampa Bay, Florida in the Gulf of Mexico (pers. comm. Ramon Ruiz-Carus). Juvenile lionfish have been observed in increasingly high numbers off New Jersey, New York and Rhode Island, generally in the fall of the year. Lionfish reports from the public (beginning in 2000) combined with quantitative surveys conducted from Florida to North Carolina (2004-2006) suggest that the number of lionfish continues to increase along the east coast and their distribution is expanding both in the northern (juveniles in northeast) and southern range (Whitfield et al. 2006, Whitfield unpublished data). Due to the large geographic range now inhabited by lionfish this invasion is likely irreversible as removal of this invader across this region would be expensive and take unprecedented resources.

Introductions of marine species occur in many ways. Ballast water discharge is a very common method of introduction for marine invertebrates, and is responsible for many freshwater fish introductions. In contrast, most marine fish introductions have resulted from intentional stocking for fishery purposes. In the case of lionfish, all evidence points to an unintentional or intentional aquarium release (Hare and Whitfield 2003).

Currently no management actions have been taken to limit the effect of lionfish on the southeast United States continental shelf ecosystem. Under this scenario we predict that; 1) the lionfish population and geographic range will continue to increase; 2) as a result of this increasing abundance, the impacts of lionfish on the southeast United States continental shelf ecosystem will become more noticeable; 3) eventually, human impacts from lionfish ‘stings’ will occur along the southeast United States coast (Hare and Whitfield 2003, Whitfield et al. 2006).

The introduction and success of lionfish along the east coast may change the long-held perception that marine fish invasions are a minimal threat to marine ecosystems The magnitude of this invasion as a stressor on marine ecosystems presently has not been quantified, but NOAA scientists have made a great deal of progress in understanding the lionfish introduction into the Western Atlantic. We have also made significant inroads in our understanding of many aspects of lionfish biology and ecology including reproduction, diet, population demographics and genetics. This section summarizes the current state of knowledge regarding the Atlantic lionfish population within five main topic areas: 1) Description and Distribution, 2) Reproduction, 3) Development, growth movement patterns and genetics, 4) Ecological relationships/Potential Impact 5) Abundance and status of the stock.

Description and Distribution

The Indo-Pacific lionfish (*Pterois volitans/miles* complex, Scorpaenidae) is a venomous predator (Halstead 1970) native to the sub-tropical and tropical regions of the South Pacific, Indian Oceans and the Red Sea (Schultz 1986). Lionfish are generally well known and recognized as a popular aquarium fish. Lionfish have venomous dorsal, anal, and pelvic spines, similar to other members of the family Scorpeanidae. The venomous spines are not known to be used in prey capture but are generally thought to be for self-defense and male/male agonistic displays during spawning (Fishelson 1975).

The present distribution (October 2006) of Indo-Pacific lionfish within the Atlantic is from south Florida to North Carolina, including Bermuda, the Bahamas, Turks and Caicos and along the northeast U.S. shelf as juveniles. Lionfish may have originated off the east coast of Florida in the early 1990's, but the actual source of the lionfish invasion remains unknown. In 2000, lionfish were first reported in North Carolina and Bermuda. In 2004, lionfish were first reported in the Bahamas, and in 2006 they were reported in the Turks and Caicos. Public reports combined with quantitative surveys suggest that both the number and geographic extent of the population continues to grow (Whitfield et al. 2006).

Within their native range lionfish are found on coral reefs and rocky outcrops from the surface to 50 meters (Schultz 1986). Within the South Atlantic Bight lionfish are widespread in abundance, found on all types of habitat (low relief hard bottom to high relief artificial structures) within water depths from 115 to 300 ft deep (Whitfield et al. 2006). By all accounts lionfish were already established (reproducing and dispersing) by the time the first surveys were conducted in 2004 and lionfish captures by hook and line are also on the rise within the past two years but these captures still vastly under-represent the extent of the lionfish population within the Atlantic. The large geographic extent of the lionfish distribution and the speed with which they occupied this area (since 2000) suggest they are very successful colonizers and competitors within their 'new' ecosystem (Atlantic).

At present the primary factors that can potentially limit their distribution are available habitat, availability of prey and winter bottom water temperatures. Both habitat and prey appear to be plentiful, especially with the potential increase in prey resources made available through overfishing of many grouper species (likely competitors for prey) (Huntsman et al. 1999, NMFS 2004). Thus the minimum bottom water temperatures remain the single most important factor in controlling the present lionfish distribution within the Atlantic. This is not only evidenced by the shift in depth distribution from their native habitat (shallower) to the Atlantic (deeper) but also by winter bottom water temperature data collected in both near shore (colder) and offshore (warmer; Gulf Stream influenced) locations (Whitfield et al. 2002, Whitfield et al. unpublished data). Minimum winter bottom water temperatures collected from locations where lionfish are known to over-winter support the thermal minimums found in laboratory studies (Kimball et al.

2004). Based on laboratory thermal minimums, lionfish would not survive water temperatures that dip below 10º C (Kimball et al. 2004). In North Carolina this equates to an inshore depth limit of approximately 80 to 90 ft, depending on winter temperatures overall. Nevertheless, lionfish can still recruit into shallower areas but they are not expected to over-winter in shallow water (< 80-90ft) north of Florida (see Figure 5, Kimball et al. 2004). However, since the thermal tolerance of fishes is known to change with changes in fish size and age (Wootton 1992), a series of mild winters could interact with the advancing size and age of Atlantic lionfish, eventually establishing subpopulations inshore of those currently surveyed. Therefore, the actual inshore limit remains unresolved off the Mid-Atlantic states. At their southern limit (South Florida, Bahamas, Turks and Caicos and Gulf of Mexico) there are no such depth or temperature constraints as water temperature remains warm year round. Thus lionfish have been reported in water depths as shallow as 3 ft in the Bahamas and Jacksonville, FL (Ruiz-Carus et al. 2006).

It is important to mention that although connectivity between the Bahamas and the Caribbean is low, there are certain locations such as the Turks and Caicos where connectivity is higher (Cowen et al. 2006). Since lionfish have free-floating eggs and larvae even minimal larval connectivity from the southeast U.S. and Bahamas could lead to invasion of the Caribbean and the Gulf of Mexico through a stepping-stone effect (Carr & Reed 1993, Cowen et al. 2006).

Reproduction

Lionfish can be characterized as gonochoristic, iteroparous, asynchronous, indeterministic batch spawners. This mode of reproduction is consistent with other members of the *Pterois* and *Dendrochirus* genera.   Lionfish appear to be summer spawners off North Carolina with a resting period lasting throughout the winter. The lionfish spawning season is likely increase at the sourthern range of their distribution (i.e, Florida/Bahamas).

From observations in the Red Sea, Fishelson (1975) has reported that lionfish are pair-spawners exhibiting a complex courtship during mating. Laboratory and shipboard observations indicate that lionfish release two buoyant egg balls during each spawning event consisting of a batch fecundity of approximately 30,000 eggs. Lionfish eggs are released while encased in a gelatinous mucus which breaks apart releasing the developing embryos within 48 hours. Lionfish do not exhibit sexual dimorphism;however, males do grow significantly larger than females. Sex ratio of lionfish in the Atlantic is approximately 1:1.   Female lionfish appear to be sexually mature within two years of age corresponding to approximately 150 mm standard length (Morris, J.A., Jr., pers. comm.).

In their native range lionfish are reported as being solitary defending their home range against conspecifics; groups were typically observed only during mating (Fishelson, 1975). In contrast within the Atlantic, lionfish are regularly found in groups, but, to our knowledge no mating behavior has been observed (Whitfield pers. obs.).

Development, growth, age, movement patterns and genetics

The early life history stages of lionfish are poorly known. Mito and Uchida (1958) and Fishelson (1975) describe the development and early larval stages of congenerics, while Imamura and Yabe (1996) describe five *P. volitans* larvae collected in the water column off of northwestern Australia. Lionfish settle from the water column to benthic habitats at about 10-12 mm. Laidig and Sakuma (1998) reported a larval growth rate of 0.3 mm d-1 for *Scorpaena*, a genus in the same family as lionfish, Scorpeanidae. Using this growth rate, the estimated planktonic larval duration (PLD) of lionfish is 25 to 40 d, which means that larvae may be in the water column and susceptible to transport by ocean currents for approximately one month. However, confirmation of PLD specific to *P. volitans* is needed as PLD can vary widely, even within members of the same genus (Victor 1986).

In 2004 a total of 149 lionfish were collected off North Carolina for life history analyses, These ranged in length from 5 to 45 cm (average length = 30.5 cm) and in weight from 25 to 1380 grams (3 lbs) with average wt of 480 grams. Several lionfish collected in this study were larger (45 cm) than the reported maximum length from their native range (38 cm) (Schultz 1986, Randall et al. 1997, Myers 1999), suggesting that lionfish growth along the southeast U.S. is not resource limited (Elton 1958). The growth rate of lionfish in the Atlantic or in their native habitat remains unknown.

Although preliminary, analyses of annual zones on sagittal otoliths suggest that the lionfish population off North Carolina is relatively young, (max. age 7 years old; 43 cm specimen). If confirmed, these results would support our general timeline of the invasion which we believe began around the year 2000, off North Carolina. However, age validation is still required to confirm this result.

As in most reef fishes, the major dispersal phase of lionfish probably occurs while eggs and larvae are in the plankton. The northward dispersal (i.e. from Florida to NC) of lionfish is thought to be greatly facilitated by the strong northerly flowing Gulf Stream currents. Dispersal further into the northeast is most likely facilitated by Gulf Stream eddies (e.g. cross shelf transport, Hare and Cowen 1996). Once settled to the benthos, observations from their native habitat suggest that lionfish exhibit site fidelity and do not migrate (Fishelson 1975, 1997, McBride and Able). In the Atlantic, however, the question of lionfish movement or migration, especially in response to cold water incursions, remains an important area of research but to date is unknown. If lionfish did move offshore in the winter in response to cold bottom water temperatures, this may increase their ability to survive thereby decreasing their natural mortality.

Genetics analyses of the Atlantic lionfish specimens revealed the presence of two closely related sister species *Pterois volitans* and *P. miles* within the Atlantic but 93.5% of collected specimens were *P. volitans*. We also found that the complexity of the haplotype network for Atlantic specimens was greatly simplified when compared to specimens in their native range. Twenty-eight different haplotypes were found within 43 native range *P. volitans* as opposed to 3 haplotypes within the 160 Atlantic *P. volitans* specimens. In addition, 95% of the Atlantic *P. volitans* shared the same haplotype. These data indicate a large decrease in genetic diversity within the Atlantic population most likely caused by a small founder population, but of no less than 3 female specimens. These data may indicate that a small release in the right environment can result in an invasion of impressive proportions.

Ecological relationships – Potential Impact

Within their native habitat the ecology of lionfish is not well known. A few studies on lionfish found they consumed a wide variety of smaller fishes, shrimps and crabs (Fishelson, 1975), and occupy the upper levels of the food chain (Fishelson, 1997). Moreover, few predators of lionfish have been reported in their native range (but see, Bernadsky and Goulet, 1991, Moyer and Zaiser 1981). Although, potential lionfish predators along the southeast United States have no experience with the venomous spines of the lionfish (Ray and Coates, 1958, Halstead, 1967) there are other native venomous fishes such as scorpionfishes (same family as lionfish) which are consumed by native predatory fishes (Randall 1967, Ebert et al. 1991, Roel and Macpherson 1998, Bowman et al. 2000). However, the potential role of predation in decreasing the number of lionfish is unknown, as is the effect of lionfish on predators.

Lionfish could impact native ecosystems through direct predation, competition and overcrowding. Preliminary data on the diet of Atlantic lionfish specimens suggest that they are primarily generalist piscivores, similar to their native counterparts. The Atlantic lionfish diet is comprised mainly of prey from a variety of fish families including members of the Serranidae, Pomacentridae, Labridae, Scaridae, Blenniidae, Bothidae, Carangidae, and Monacanthidae. Ninety eight percent of stomachs examined contained fishes, and other prey items (decapod crustaceans, cephalopod and bivalve mollusks) make up only a fraction of prey contents by volume (approx. 0.5 % or less). The small serranids (sea basses) were substantially more important in terms of volume than other families of fishes (41% vs 15% and lower for other prey families) (Munoz et al. in prep). Since lionfish are opportunistic predators feeding primarily on smaller fishes, there is potential for trophic overlap with native fishes (Sano et al. 1984, Naughton 1985, Matheson et al. 1986, Fishelson 1997) such as groupers in the genus Mycteroperca. Groupers comprising this genus feed almost exclusively on fishes (Dodrill et al. 1993). In particular, gag (*Mycteroperca microlepis*) and scamp (*M. phenax*) groupers are present in significant numbers off the North Carolina coast and scamp occur at size classes that appear to overlap size classes of lionfish. Serranids form one of the most important food items in the scamp diet (Matheson et al. 1986) so similarly sized scamp and lionfish may be targeting similar prey. In addition, lionfish have been confirmed to prey upon scad (Carangidae), one of the dominant fish species in the diet of gag (Naughton & Saloman 1985). If these prey fishes are already or became a limiting resource, a growing lionfish population could negatively impact the scamp and gag populations via competition for food resources. The style of lionfish predation, (i.e., ambush predator) is not unique on southeast United States reefs and wrecks (e.g., red grouper, frog fish, scorpion fish), but the lack of experience of prey species may increase the predation efficiency of lionfish. Moreover, continued mortality of groupers and other native predators through overfishing (Huntsman et al. 1999, NMFS 2004) may open niche space and further increase resources for lionfish (Davis 2000).

Lionfish may also affect the use of habitat by other species through physical overcrowding and aggressive tendencies. Lionfish are often described as ‘standing their ground’ and male-male aggression is extremely high prior to and during reproductive activities, during which lionfish will even threaten divers (Thresher 1984; Myers 1991). If this behavioral characteristic was extended towards other organisms in their introduced range, the threat might be expected to increase with lionfish abundance and potentially cause native species displacement into sub-optimum habitats (Schumacher and Parrish 2005, Taylor et al. 1984).

Abundance and status of the stock
The total population abundance of lionfish in the Atlantic is currently unknown. Quantitative surveys combined with public reports suggest the population is growing in number and increasing in geographic extent and may potentially colonize the entire Caribbean and Gulf of Mexico (Whitfield et al. 2006). Within the last two years quantitative surveys at the same nineteen locations off North Carolina (95 to 150 fsw) indicate that lionfish densities have doubled. Moreover, yearly surveys from the same nineteen locations, off North Carolina, suggest lionfish densities may be similar to many native fish species (i.e., *Cephalopholis cruentatus*, *Epinephelus guttatus*, *E. adscensonis*, *Mycteroperca interstitialis*, *M.microlepis*) (Whitfield et al. 2006). At this point there is every expectation that the total population and geographic extent of lionfish will continue to increase. More information is clearly needed to determine the status of the entire population, but traditional fishery sampling methods are not appropriate because lionfish are not captured effectively in this manner. More detailed information on the amount and type of benthic habitat within the southeast region combined with a random program of quantitative visual surveys over a broad geographic area (Bahamas to NC) will assist in estimating the total population size of lionfish.

Summary
The southeast United States continental shelf ecosystem is already undergoing change. Many important reef fish predators are overfished (Huntsman et al., 1999). In the Snapper-Grouper Management Unit of the South Atlantic Fisheries Management Council, approximately half of the stocks for which the status is known are classified as overfished. The reef fish fauna of the southeast United States continental shelf is also becoming more tropical (Parker and Dixon, 1998). From the 1970’s to the 1990’s, the number of tropical species and the abundance of individual tropical species increased off the coast of North Carolina. Both of these large-scale changes favor the continued growth and dispersal of the lionfish population along the southeast United States. The effect of climate change, overfishing and invasive species have been implicated in ecosystem decline and collapse in several marine ecosystems, (Harris & Tyrrell 2001, Stachowicz et al. 2002, Frank et al. 2005). Along the southeast U.S. shelf the high number of stressors acting in synergism may eventually have unexpected and irreversible consequences for the native communities and economically valuable fisheries in this region.

6.1.3 Natural Events and Climate Change

Potential Threats to EFH from Natural Events and Climate Change

Potential threats: Coastal and inland storms can cause severe acute and chronic perturbations including habitat erosion, burial of habitat and organisms by sediment deposition; creation of strong currents that alter habitats and remove biota; damage by wind and waves; creation of turbidity levels that can cause physiological damage and disrupt feeding, spawning migration, and other vital processes; and abrupt changes in salinity and other water quality characteristics such as fecal coliform levels and harmful algal blooms. Long-term climatological changes, such as, changes in weather patterns and ocean currents,can bring about similar changes by increasing storm activity, changing fresh water inputs and salinity in coastal systems, increasing ocean acidification which affects coral reef building, and changing water column productivity that can affect certain fish population. For example, the Atlantic Multidecadal Oscillation can cause large scale ecological changes called regime shifts where temperature alterations favor or harm a particular species or group. Changes that cause relocation of frontal boundaries, weed lines, and stratification and temperature boundaries may also cause substantial and undesirable environmental change.

Coastal processes may be dramatically altered by natural events. These include short term events such as severe storms, hurricanes, floods, etc. Effects vary from potentially positive to catastrophic. For example, a moderate storm may provide needed freshwater, flush and recharge stagnant water bodies, and transfer nutrients from uplands and high marsh surfaces to tidal waters. On the other hand, shoreline erosion, wetlands destruction and subsidence and substantial changes in the structure of coral communities (e.g., Bythyell et al., 1993) are possible.

Hurricanes and other severe climatological events and change can drastically alter shorelines and associated environments including wetlands. Some changes may be positive such as the flushing of stagnant systems. However, wind induced erosion and overwash can remove and fill large areas of SAV and emergent wetlands. In overwash areas, newly created "uplands" are often quickly developed and stabilized and geomorphological processes that lead to rebuilding of wetlands and shallow water areas may be precluded. As storm activity increases in severity and regularity, emergency shoreline protection response threatens coastal nearshore habitats primarily through burial by beach restoration efforts. Littoral sand drift has interrupted by the development of stabilized inlet jetties, which has reduced sand budgets. Decreased sand budgets coupled with increased severe storm activity (a known result of increased rates of global warming) necessitate an increase in large-scale beach dredge and fill projects. The direct, secondary and cumulative effects of these activities are known to have a profound effect on EFH through burial of nearshore hard bottom, worm reef, coral reef and sand bottom habitat areas. Loss of habitat areas utilized by various life stages of federally managed species and their prey species will continue to have a negative effect. As the need for such projects increases and the time between projects decreases adverse effects will be amplified.

Hurricanes also cause vertical mixing in coastal waters that results in cooling and nutrient enrichment of surface water and stimulation of algal growth. In estuaries, hurricanes suspend sediment and increase terrestrial runoff that can result in algal blooms and hypoxia in bottom waters (NOAA, 2005). Algal blooms and hypoxia can cause fish dieoffs and spread disease to other plants and animals.

Climate Change

This section was excerpted from the *Summary Report for Policymakers* based on the assessment carried out by the three Working Groups of the Intergovernmental Panel on Climate Change (IPCC). It provides an integrated view of climate change as the final part of the IPCC's Fourth Assessment Report, released in fall 2007. A complete elaboration of the topics covered in this summary can be found in this Synthesis Report and in the underlying reports of the three Working Groups available online at (http://www.coastalclimate.org/).

<u>Observed changes in climate and their effects</u>

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (**Figure 6.1-2**).

Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The 100-year linear trend (1906-2005) of 0.74 [0.56 to 0.92]°C 1 is larger than the corresponding trend of 0.6 [0.4 to 0.8]°C (1901-2000) given in the Third Assessment Report (TAR) (**Figure 6.1-2**). The temperature increase is widespread over the globe, and is greater at higher northern latitudes.

Land regions have warmed faster than the oceans (**Figure 6.1-3**). Rising sea level is consistent with warming (**Figure 6.1-2**) Global average sea level has risen since 1961 at an average rate of 1.8 [1.3 to 2.3]mm/yr and since 1993 at 3.1 [2.4 to 3.8]mm/yr, with contributions from thermal expansion, melting glaciers and ice caps, and the polar ice sheets. Whether the faster rate for 1993 to 2003 reflects decadal variation or an increase in the longer-term trend is unclear.

Observed decreases in snow and ice extent are also consistent with warming (Figure SPM.1). Satellite data since 1978 show that annual average Arctic sea ice extent has shrunk by 2.7 [2.1 to 3.3]% per decade, with larger decreases in summer of 7.4 [5.0 to 9.8]% per decade. Mountain glaciers and snow cover on average have declined in both hemispheres.

From 1900 to 2005, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia but declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. Globally, the area affected by drought has likely increased since the 1970s.

It is very likely that over the past 50 years: cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent. It is likely that: heat waves have become more frequent over most land areas, the frequency of heavy precipitation events has increased over most areas, and since

1975 the incidence of extreme high sea level has increased worldwide.

There is observational evidence of an increase in intense tropical cyclone activity in the North Atlantic since about 1970, with limited evidence of increases elsewhere. There is no clear trend in the annual numbers of tropical cyclones. It is difficult to ascertain longer-term trends in cyclone activity, particularly prior to 1970.

Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1300 years.

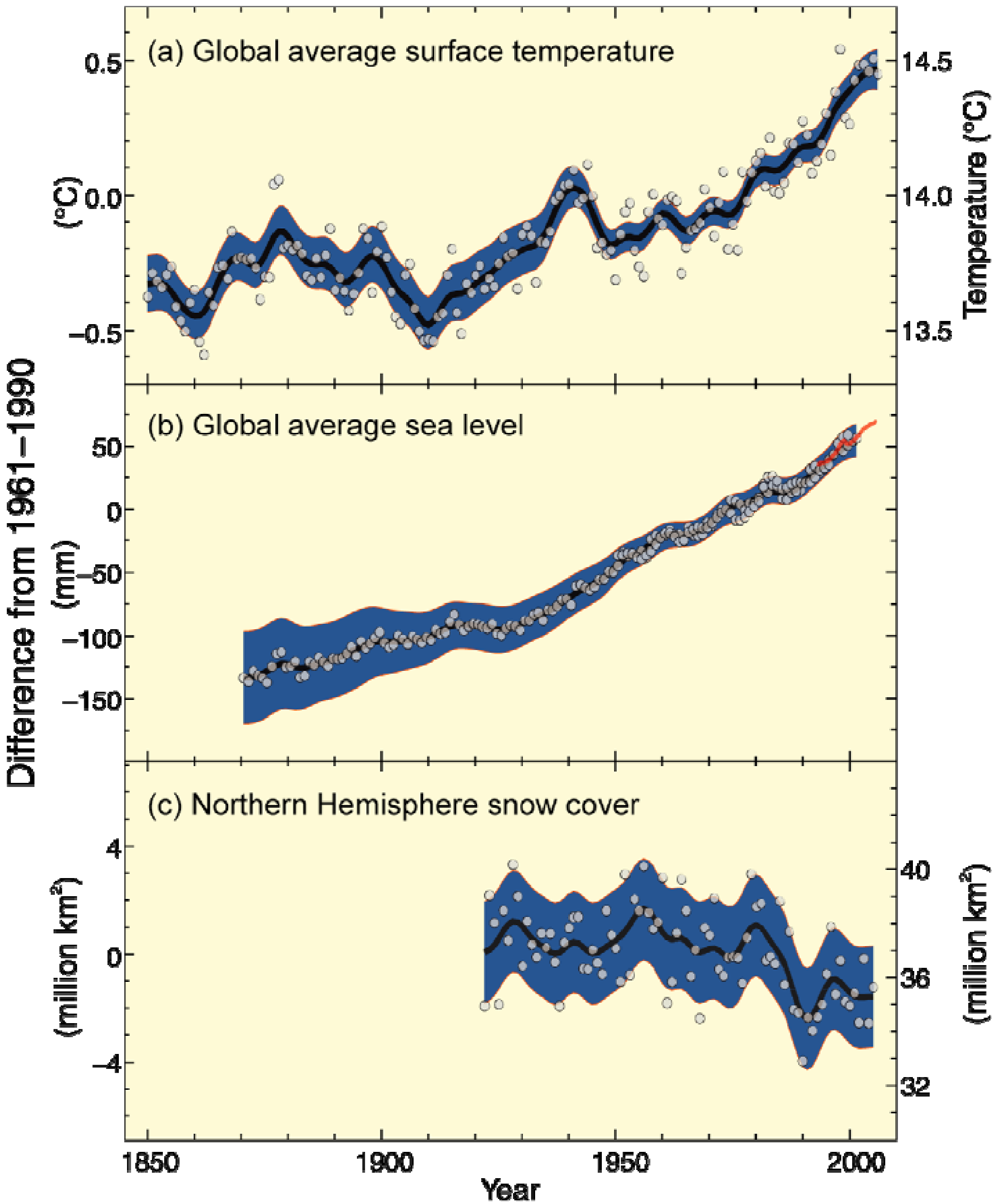

Figure 6.1-2. Observed changes in (a) global average surface temperature; (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c).

Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. Changes in snow, ice and frozen ground have with high confidence increased the number and size of glacial lakes, increased ground instability in mountain and other permafrost regions, and led to changes in some Arctic and Antarctic ecosystems.

There is high confidence that some hydrological systems have also been affected through increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers, and effects on thermal structure and water quality of warming rivers and lakes.

In terrestrial ecosystems, earlier timing of spring events and poleward and upward shifts in plant and animal ranges are with very high confidence linked to recent warming. In some marine and freshwater systems, shifts in ranges and changes in algal, plankton and fish abundance are with high confidence associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation.

Of the more than 29,000 observational data series, from 75 studies, that show significant change in many physical and biological systems, more than 89% are consistent with the direction of change expected as a response to warming. However, there is a notable lack of geographic balance in data and literature on observed changes, with marked scarcity in developing countries.

There is medium confidence that other effects of regional climate change on natural and human environments are emerging, although many are difficult to discern due to adaptation and non-climatic drivers. They include effects of temperature increases on:

- agricultural and forestry management at Northern Hemisphere higher latitudes, such as earlier spring planting of crops, and alterations in disturbance regimes of forests due to fires and pests
- some aspects of human health, such as heat-related mortality in Europe, changes in infectious disease vectors in some areas, and allergenic pollen in Northern Hemisphere high and mid-latitudes
- some human activities in the Arctic (e.g. hunting and travel over snow and ice) and in lower-elevation alpine areas (such as mountain sports).

<u>Causes of change</u>

Changes in atmospheric concentrations of greenhouse gases (GHGs) and aerosols, land-cover and solar radiation alter the energy balance of the climate system.

Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004. Carbon dioxide (CO_2) is the most important anthropogenic GHG. Its annual emissions grew by about 80% between 1970 and 2004. The long-term trend of declining CO_2 emissions per unit of energy supplied reversed after 2000.

Global atmospheric concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years.

Atmospheric concentrations of CO_2 (379ppm) and CH_4 (1774 ppb) in 2005 exceed by far the natural range over the last 650,000 years. Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution. It is very likely that the observed increase in CH_4 concentration is predominantly due to agriculture and fossil fuel use. Methane growth rates have declined since the early 1990s, consistent with total emissions (sum of anthropogenic and natural sources) being nearly constant during this period. The increase in N_2O concentration is primarily due to agriculture.

There is very high confidence that the net effect of human activities since 1750 has been one of warming.

Most of the observed increase in globally-averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations. It is likely there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica) (Figure SPM.4).

During the past 50 years, the sum of solar and volcanic forcings would likely have produced cooling. Observed patterns of warming and their changes are simulated only by models that include anthropogenic forcings. Difficulties remain in simulating and attributing observed temperature changes at smaller than continental scales.

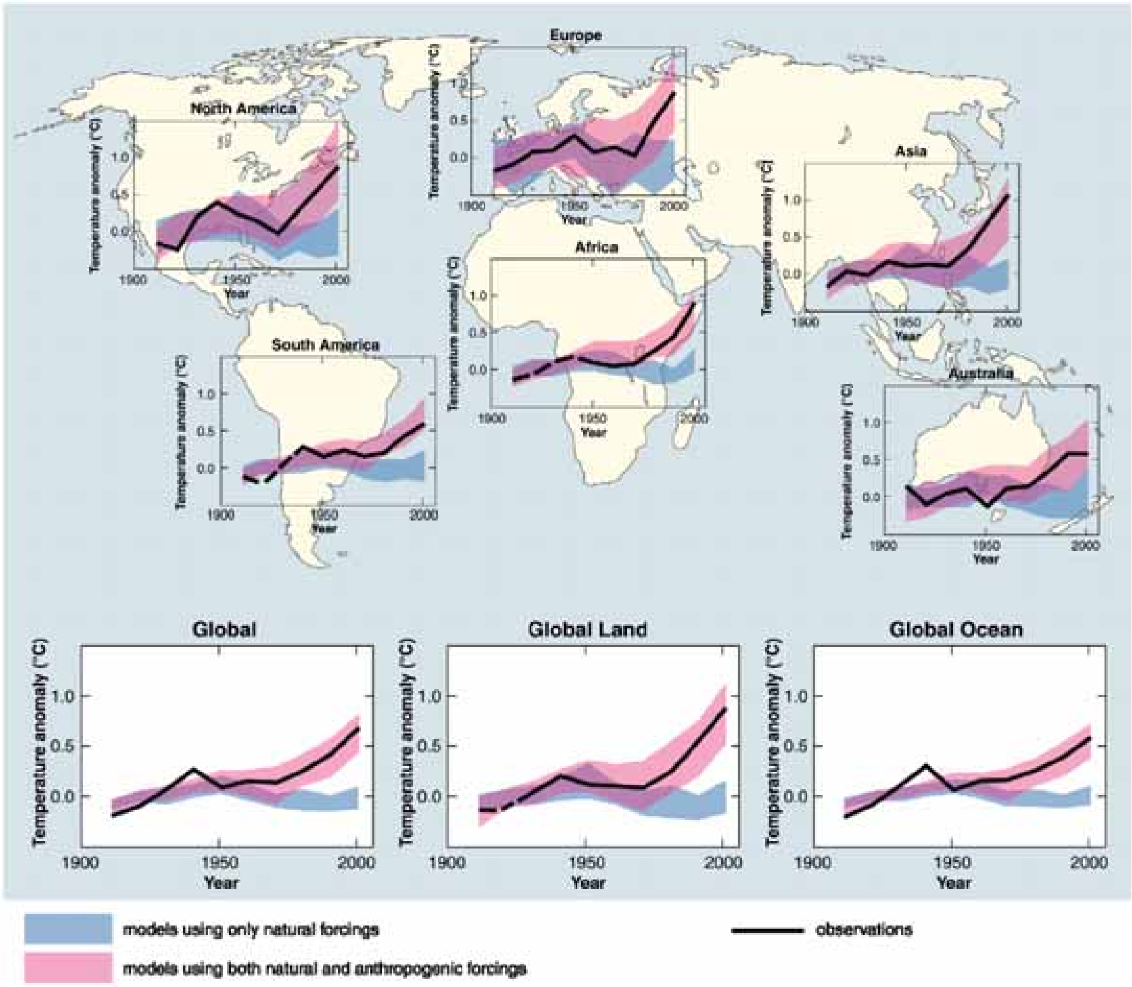

Figure 6.1-3. Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906-2005 (black line) plotted against the centre of the decade and relative to the corresponding average for the period 1901-1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5-95% range for 19 simulations from 5 climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5-95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings.

Advances since the TAR show that discernible human influences extend beyond average temperature to other aspects of climate.

Human influences have:

- very likely contributed to sea level rise during the latter half of the 20th century
- likely contributed to changes in wind patterns, affecting extra-tropical storm tracks and temperature patterns
- likely increased temperatures of extreme hot nights, cold nights and cold days

- more likely than not increased risk of heat waves, area affected by drought since the 1970s and frequency of heavy precipitation events.

Anthropogenic warming over the last three decades has likely had a discernible influence at the global scale on observed changes in many physical and biological systems. Spatial agreement between regions of significant warming across the globe and locations of significant observed changes in many systems consistent with warming is very unlikely to be due solely to natural variability. Several modeling studies have linked some specific responses in physical and biological systems to anthropogenic warming.

More complete attribution of observed natural system responses to anthropogenic warming is currently prevented by the short time scales of many impact studies, greater natural climate variability at regional scales, contributions of non-climate factors and limited spatial coverage of studies.

Projected climate change and its impacts

There is high agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades.

The IPCC Special Report on Emission Scenarios (SRES, 2000) projects an increase of global GHG emissions by 25-90% (CO_2-eq) between 2000 and 2030, with fossil fuels maintaining their dominant position in the global energy mix to 2030 and beyond. More recent scenarios without additional emissions mitigation are comparable in range.

Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century. For the next two decades a warming of about 0.2°C per decade is projected for a range of SRES emission scenarios. Even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. Afterwards, temperature projections increasingly depend on specific emission scenarios.

For an explanation of SRES emission scenarios, see Box 'SRES scenarios' in Topic 3 of this Synthesis Report. These scenarios do not include additional climate policy above current ones; more recent studies differ with respect to UNFCCC and Kyoto Protocol inclusion.

There is now higher confidence than in the TAR in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation, and some aspects of extremes and sea ice. Regional-scale changes include:

- warming greatest over land and at most high northern latitudes and least over Southern Ocean and parts of the North Atlantic Ocean, continuing recent observed trends **(Figure 6.1-4)**;
- contraction of snow cover area, increases in thaw depth over most permafrost regions, and decrease in sea ice extent; in some projections using SRES scenarios,

Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century;
- very likely increase in frequency of hot extremes, heat waves, and heavy precipitation;
- likely increase in tropical cyclone intensity; less confidence in global decrease of tropical cyclone numbers;
- poleward shift of extra-tropical storm tracks with consequent changes in wind, precipitation, and temperature patterns; and
- very likely precipitation increases in high latitudes and likely decreases in most subtropical land regions, continuing observed recent trends.

There is high confidence that by mid-century, annual river runoff and water availability are projected to increase at high latitudes (and in some tropical wet areas) and decrease in some dry regions in the mid-latitudes and tropics. There is also high confidence that many semi-arid areas (e.g. Mediterranean basin, western United States, southern Africa and northeast Brazil) will suffer a decrease in water resources due to climate change.

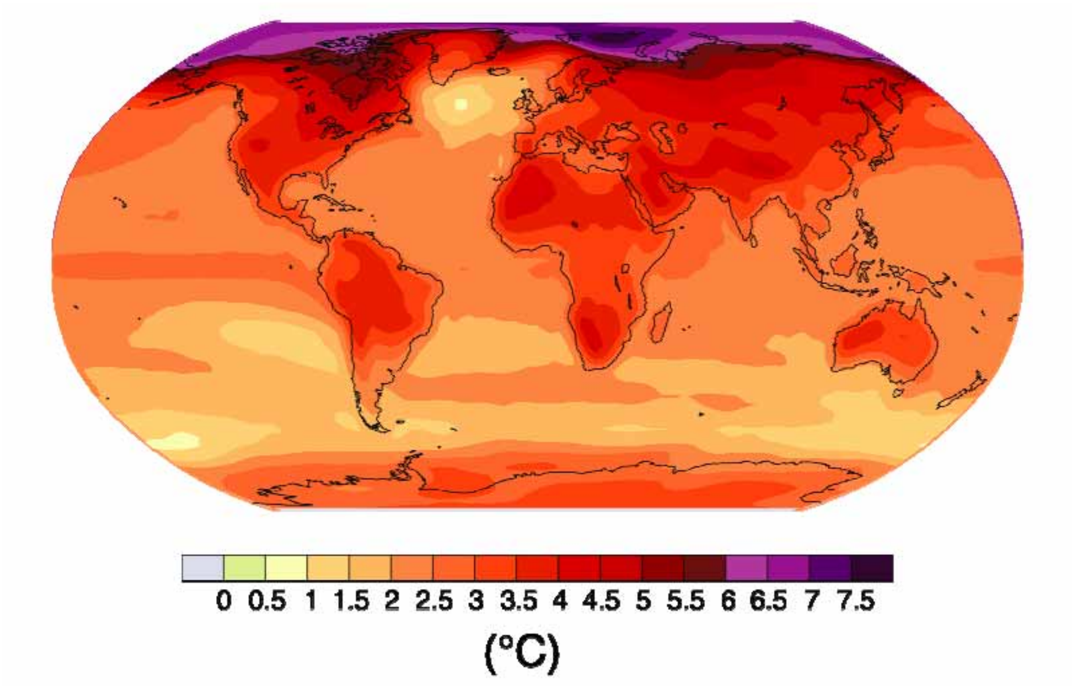

Figure 6.1-4. Projected surface temperature changes for the late 21st century (2090-2099). The map shows the multi- AOGCM average projection for the A1B SRES scenario. All temperatures are relative to the period 1980-1999.

Studies since the TAR have enabled more systematic understanding of the timing and magnitude of impacts related to differing amounts and rates of climate change.

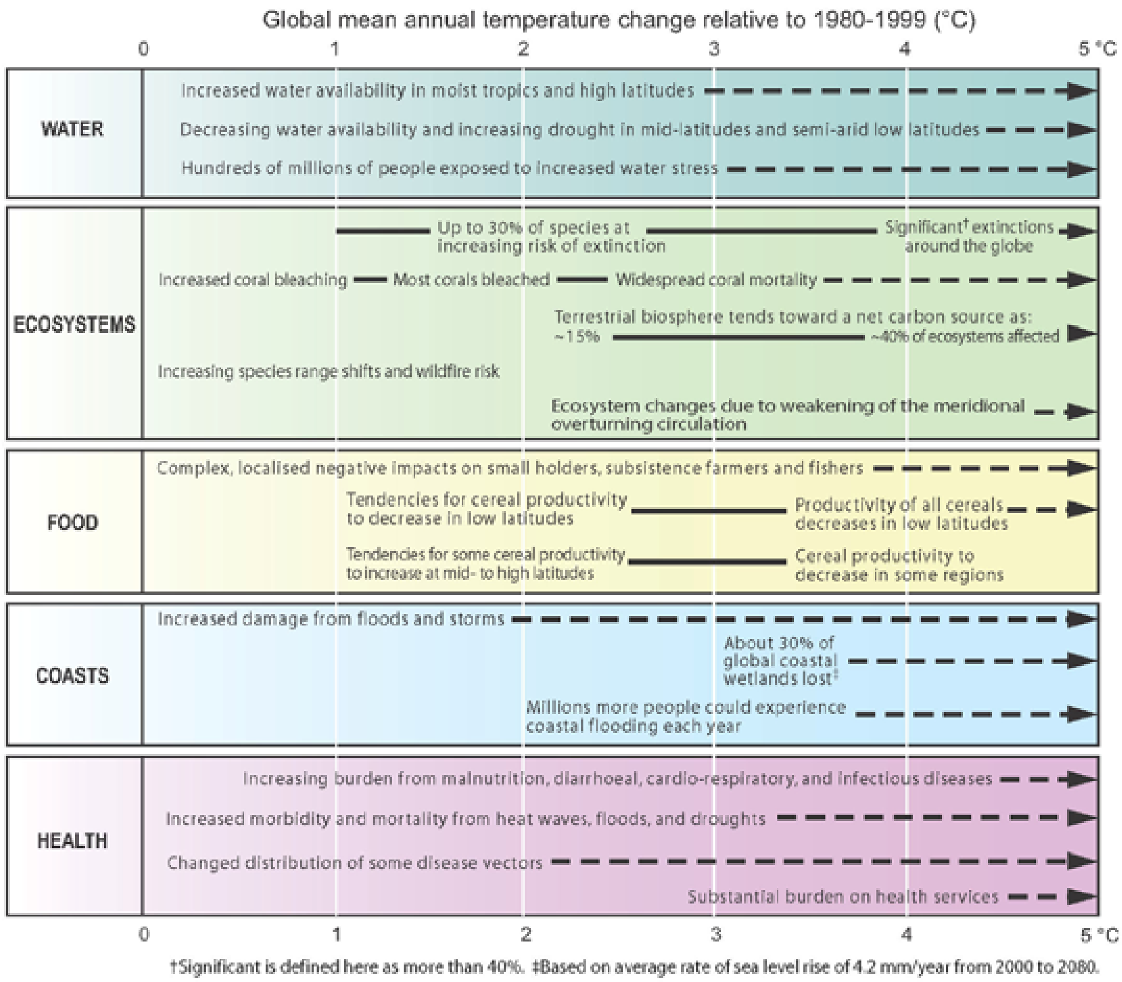

Figure 6.1-5. Illustrative examples of global impacts projected for climate changes (and sea level and atmospheric CO_2 where relevant) associated with different amounts of increase in global average surface temperature in the 21st century. The black lines link impacts; broken line arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left hand side of text indicates the approximate level of warming that is associated with the onset of a given impact. Quantitative entries for water scarcity and flooding represent the additional impacts of climate change relative to the conditions projected across the range of SRES model scenarios. Adaptation to climate change is not included in these estimations. *Confidence levels for all statements are high.*

Examples of some projected regional impacts in North America:

- Warming in western mountains is projected to cause decreased snowpack, more winter flooding, and reduced summer flows, exacerbating competition for over-allocated water resources.
- In the early decades of the century, moderate climate change is projected to increase aggregate yields of rain-fed agriculture by 5-20%, but with important variability among regions. Major challenges are projected for crops that are near

the warm end of their suitable range or which depend on highly utilized water resources.

- During the course of this century, cities that currently experience heatwaves are expected to be further challenged by an increased number, intensity and duration of heatwaves during the course of the century, with potential for adverse health impacts.
- Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution.

Moreover, some systems, sectors and regions are likely to be especially affected by climate change.

- Particular ecosystems
    - terrestrial: tundra, boreal forest and mountain regions because of sensitivity to warming; mediterranean-type ecosystems because of reduction in rainfall; and tropical rainforests where precipitation declines
    - coastal: mangroves and salt marshes, due to multiple stresses
    - marine: coral reefs due to multiple stresses; the sea ice biome because of sensitivity to warming
- Water resources in some dry regions at mid-latitudes and in the dry tropics, due to changes in rainfall and evapotranspiration, and in areas dependent on snow and ice melt agriculture in low-latitudes, due to reduced water availability.
- Low-lying coastal systems, due to threat of sea level rise and increased risk from extreme weather events.
- Human health in populations with low adaptive capacity.

Altered frequencies and intensities of extreme weather, together with sea level rise, are expected to have mostly adverse effects on natural and human systems.
Examples for selected extremes and sectors are shown in **Table 6.1-3.**

Table 6.1-3. Examples of possible impacts of climate change due to changes in extreme weather and climate events, based on projections to the mid- to late 21st century. These do not take into account any changes or developments in adaptive capacity. The likelihood estimates in column two relate to the phenomena listed in column one.

Phenomenon[a] and direction of trend	Likelihood of future trends based on projections for 21[st] century using SRES scenarios	Examples of major projected impacts by sector			
		Agriculture, forestry and ecosystems	Water resources	Human health	Industry, settlement and society
Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	*Virtually certain*[b]	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks	Effects on water resources relying on snowmelt; effects on some water supplies	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating; increased demand for cooling; declining air quality in cities; reduced disruption to transport due to snow, ice; effects on winter tourism
Warm spells/heat waves. Frequency increases over most land areas	*Very likely*	Reduced yields in warmer regions due to heat stress; increased danger of wildfire	Increased water demand; water quality problems, e.g. algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially isolated	Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor
Heavy precipitation events. Frequency increases over most areas	*Very likely*	Damage to crops; soil erosion, inability to cultivate land due to waterlogging of soils	Adverse effects on quality of surface and groundwater; contamination of water supply; water scarcity may be relieved	Increased risk of deaths, injuries and infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding; pressures on urban and rural infrastructures; loss of property
Area affected by drought increases	*Likely*	Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire	More widespread water stress	Increased risk of food and water shortage; increased risk of malnutrition; increased risk of water-and food-borne diseases	Water shortage for settlements, industry and societies; reduced hydropower generation potentials; potential for population migration
Intense tropical cyclone activity increases	*Likely*	Damage to crops; windthrow (uprooting) of trees; damage to coral reefs	Power outages causing disruption of public water supply	Increased risk of deaths, injuries, water- and food-borne diseases; post-traumatic stress disorders	Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers, potential for population migrations, loss of property
Increased incidence of extreme high sea level (excludes tsunamis)[c]	*Likely*[d]	Salinisation of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to saltwater intrusion	Increased risk of deaths and injuries by drowning in floods; migration-related health effects	Costs of coastal protection versus costs of land-use relocation; potential for movement of populations and infrastructure; also see tropical cyclones above

Notes:
a) See WGI Table 3.7 for further details regarding definitions.
b) Warming of the most extreme days and nights each year.
c) Extreme high sea level depends on average sea level and on regional weather systems. It is defined as the highest 1% of hourly values of observed sea level at a station for a given reference period.
d) In all scenarios, the projected global average sea level at 2100 is higher than in the reference period. The effect of changes in regional weather systems on sea level extremes has not been assessed.

Anthropogenic warming could lead to some impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change. Partial loss of ice sheets on polar land could imply meters of sea level rise, major changes in coastlines and inundation of low-lying areas, with greatest effects in river deltas and low-lying islands. Such changes are projected to occur over millennial time scales, but more rapid sea level rise on century time scales cannot be excluded.

Climate change is likely to lead to some irreversible impacts. There is medium confidence that approximately 20-30% of species assessed so far are likely to be at increased risk of extinction if increases in global average warming exceed 1.5-2.5°C (relative to 1980-1999). As global average temperature increase exceeds about 3.5°C, model projections suggest significant extinctions (40-70% of species assessed) around the globe.

Based on current model simulations, the meridional overturning circulation (MOC) of the Atlantic Ocean will very likely slow down during the 21st century; nevertheless temperatures over the Atlantic and Europe are projected to increase. The MOC is very unlikely to undergo a large abrupt transition during the 21stcentury. Longer-term MOC changes cannot be assessed with confidence. Impacts of large-scale and persistent changes in the MOC are likely to include changes in marine ecosystem productivity, fisheries, ocean CO_2 uptake, oceanic oxygen concentrations and terrestrial vegetation. Changes in terrestrial and ocean CO_2 uptake may feed back on the climate system.

The five "reasons for concern" identified originally in the IPCC's Third Assessment Report (TAR) remain a viable framework to consider key vulnerabilities. These "reasons" are assessed here to be stronger than in the TAR. Many risks are identified with higher confidence. Some risks are projected to be larger or to occur at lower increases in temperature.

Understanding about the relationship between impacts (the basis for "reasons for concern" in the TAR) and vulnerability (that includes the ability to adapt to impacts) has improved. This is due to more precise identification of the circumstances that make systems, sectors and regions especially vulnerable, and growing evidence of the risks of very large impacts on multiple century time scales.

- **Risks to unique and threatened systems.** There is new and stronger evidence of observed impacts of climate change on unique and vulnerable systems (such as polar and high mountain communities and ecosystems), with increasing levels of adverse impacts as temperatures increase further. An increasing risk of species extinction and coral reef damage is projected with higher confidence than in the TAR as warming proceeds. There is medium confidence that approximately 20-30% of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5-2.5°C over 1980-1999 levels. Confidence has increased that a 1-2°C increase in global mean temperature above 1990 levels (about 1.5-2.5°C above pre-industrial) poses significant risks to many unique and threatened systems including many biodiversity hotspots. Corals are vulnerable to thermal stress and have low adaptive capacity. Increases in sea surface temperature of about 1-3°C are projected to result in more frequent coral bleaching events and widespread mortality, unless there is thermal adaptation or acclimatization by corals. Increasing vulnerability of indigenous communities in the Arctic and small island communities to warming is projected.

- **Risks of extreme weather events.** Responses to some recent extreme events reveal higher levels of vulnerability than the TAR. There is now higher confidence in the projected increases in droughts, heat waves, and floods as well as their adverse impacts.
- **Distribution of impacts and vulnerabilities.** There are sharp differences across regions and those in the weakest economic position are often the most vulnerable to climate change. There is increasing evidence of greater vulnerability of specific groups such as the poor and elderly in not only developing but also developed countries. Moreover, there is increased evidence that low-latitude and less-developed areas generally face greater risk, for example in dry areas and megadeltas.
- **Aggregate impacts.** Compared to the TAR, initial net market-based benefits from climate change are projected to peak at a lower magnitude of warming, while damages would be higher for larger magnitudes of warming. The net costs of impacts of increased warming are projected to increase over time.
- **Risks of large-scale singularities.** There is high confidence that global warming over many centuries would lead to a sea level rise contribution from thermal expansion alone which is projected to be much larger than observed over the 20th century, with loss of coastal area and associated impacts. There is better understanding than in the TAR that the risk of additional contributions to sea level rise from both the Greenland and possibly Antarctic ice sheets may be larger than projected by ice sheet models and could occur on century time scales. This is because ice dynamical processes seen in recent observations but not fully included in ice sheet models assessed in AR4 could increase the rate of ice loss.

There is high confidence that neither adaptation nor mitigation alone can avoid all climate change impacts; however, they can complement each other and together can significantly reduce the risks of climate change.

Adaptation is necessary in the short and longer term to address impacts resulting from the warming that would occur even for the lowest stabilization scenarios assessed. There are barriers, limits and costs, but these are not fully understood. Unmitigated climate change would, in the long term, be likely to exceed the capacity of natural, managed and human systems to adapt. The time at which such limits could be reached will vary between sectors and regions. Early mitigation actions would avoid further locking in carbon intensive infrastructure and reduce climate change and associated adaptation needs.

Many impacts can be reduced, delayed or avoided by mitigation. Mitigation efforts and investments over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels.

Delayed emission reductions significantly constrain the opportunities to achieve lower stabilization levels and increase the risk of more severe climate change impacts.
In order to stabilize the concentration of GHGs in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilization level, the more quickly this peak and decline would need to occur.

Sea level rise under warming is inevitable. Thermal expansion would continue for many centuries after GHG concentrations have stabilized, for any of the stabilization levels assessed, causing an eventual sea level rise much larger than projected for the 21st century. The eventual contributions from Greenland ice sheet loss could be several meters, and larger than from thermal expansion, should warming in excess of 1.9-4.6°C above pre-industrial be sustained over many centuries. The long time scales of thermal expansion and ice sheet response to warming imply that stabilization of GHG concentrations at or above present levels would not stabilize sea level for many centuries.

Ocean Acidification

another global change issue relates to changes in the earth's carbon budget and cycle. Carbon cycles through the earth's ecosystems in organic and inorganic forms. Recent increasing trends in carbon dioxide in the earth's atmosphere is shifting the cycle of carbon in the ocean and increasing carbonic acid and a gradual decrease in ocean pH and calcium carbonate. Experimental evidence suggests that if these trends continue, key marine organisms—such as corals and some plankton—will have difficulty maintaining their external calcium carbonate skeletons (Orr, et al., 2005).

According to the Intergovernmental panel on Climate Change (2007), the uptake of anthropogenic carbon since 1750 has led to the ocean becoming more acidic with an average decrease in pH of 0.1 units. Increasing atmospheric CO_2 concentrations lead to further acidification. Projections based on SRES scenarios give a reduction in average global surface ocean pH of between 0.14 and 0.35 units over the 21st century. While the effects of observed ocean acidification on the marine biosphere are as yet undocumented, the progressive acidification of oceans is expected to have negative impacts on marine shell-forming organisms (e.g. corals) and their dependent species.

6.2 Adverse impacts of fishing activities under South Atlantic Council Fishery Management Plans

(excerpted from Barnette 2001)

All fishing has an effect on the marine environment, and therefore the associated habitat. Fishing has been identified as the most widespread hum an exploitative activity in the marine environment (Jennings and Kaiser 1998), as well as the major anthropogenic threat to demersal fisheries habitat on the continental shelf (Cappo et al. 1998). Fishing impacts range from the extraction of a species which skews community composition and diversity to reduction o f habitat complexity thro ugh direct physical impacts of fishing gear.

The nature and magnitude of t he effects of fishing activities depend heavily upon the physical and biological characteristics of a specific area in question. There are strict limitations on the degree to which probable local effects can be inferred from the studies of fishing practices conducted elsewhere (North Carolina Division of Marine Fisheries 199 9). The extreme variability that occurs with in marine habitats confounds the ability to easily evaluate habitat impacts on a regional basis. Obviously, observed impacts at coastal or nearshore sites should not be extrapolated to offshore fishing areas because of the major differences in water depth, sediment type, energy levels, and biological communities (Prena et al. 1999). 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 (e.g., deep water communities). 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 regions, the various types of fishing gear and how each is utilized on various habitat types affect the resulting potential impacts. For example, trawls vary in size and weight, as well as their impacts to the seabed. 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, that affects benthic communities. Unfortunately, a limitation to many fishing-related impact studies is that they do not measure the long term effects of chronic fishing disturbance. Furthermore, one of the most difficult aspects of estimating the extent of fishing impacts on habitat is the lack of high-resolution data on the distribution of fishing effort (Auster and Langton 1999).

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. Additionally, various gears may indirectly impact EFH. Bycatch disposal and ghost fishing are two of the more well-documented indirect impacts to EFH . While recognizing that these are serious issues that pertain to habitat, this review does not attempt to discuss these due to the secondary nature of the impacts.

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 sea bed affected by each gear is almost insignificant compared to the widespread effects of mobile gear. Regardless, static gear may negatively affect EFH and, therefore, must be considered.

The exact relationship that particular impacts have on the associated community and productivity is not fully understood. While it is clear that fishing activities impact or alter EFH, the result of those impacts or the degree of habitat alteration that still allow for sustainable fishing is 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.

6.2.1 Fishing Gear Regulations under Council FMPs

The following is a list of gear currently in use (or regulated) in fisheries managed under the South Atlantic Council fishery management plans. In general, if gear is not listed it is prohibited or not commonly used in the fishery:

<u>Snapper Grouper Fishery</u>
Vertical hook-and-line gear, including hand-held rod and manual or electric reel or "bandit gear" with manual, electric or hydraulic reel (recreational and commercial).

Spear fishing gear without rebreathers (recreational and commercial).

Powerheads, except where expressly prohibited in Special Management Zones (SMZs). In addition, the use of explosive charges, including powerheads, is prohibited in the EEZ off South Carolina (recreational and commercial).

Bottom longlines (commercial). Prohibited south of a line running east of St. Lucie Inlet, Florida (27° 10' N. lat.) and in depths less than 50 fathoms north of that line. May not be used to fish for wreckfish.

Sea bass pots (commercial). May not be used or possessed in multiple configurations. Pot size, wire mesh size and construction restrictions. May not be used in the EEZ south of a line running due east of the NASA Vehicle Assembly Building, Cape Canaveral, Florida (28° 35.1' N. lat.).

Special Management Zones (created under the Snapper Grouper FMP). Sea bass pots are prohibited in all Special Management Zones. Fishing may only be conducted with hand-held hook-and-line gear (including manual, electric, or hydraulic rod and reel) and spearfishing gear in specified Special Management Zones; however, in other specified Special Management Zones a hydraulic or electric reel that is permanently affixed to a vessel ("bandit gear") and/or spear fishing gear (or only powerheads) are prohibited.

<u>Shrimp</u>
Penaied shrimp trawls (commercial). The Shrimp Fishery Management Plan allows North and South Carolina, Georgia and east Florida to request a closure in federal waters adjacent to closed state waters for brown, pink or white shrimp following severe cold weather that results in an 80% or greater reduction in the population of white shrimp

(whiting, royal red and rock shrimp fisheries are exempt from a federal closure for white shrimp). During a federal closure, a buffer zone is established extending seaward from shore to 25 nautical miles, inside of which no trawling is allowed with a net having less than 4" stretch mesh. Vessels trawling inside this buffer zone cannot have a shrimp net aboard (i.e., a net with less than 4" stretch mesh) in the closed portion of the federal zone. Transit of the closed federal zone with less than 4" stretch mesh aboard while in possession of penaeid (white, brown and pink) species will be allowed provided that the nets are in an unfishable condition, which is defined as stowed below deck. Specified areas are closed to trawling for rock shrimp.

Rock shrimp trawls (commercial). The minimum mesh size for the cod end of a rock shrimp trawl net in the South Atlantic EEZ off Georgia and Florida is 1-7/8 inches (4.8 cm), stretched mesh. This minimum mesh size is required in at lest the last 40 meshes forward of the cod end drawstring (tie off strings), and smaller mesh bag liners are not allowed. A vessel that has a trawl net on board that does not meet these requirements may not possess a rock shrimp in or from the South Atlantic EEZ off Georgia and Florida.

Bycatch Reduction Devices (BRDs). On a penaeid shrimp trawler in the South Atlantic EEZ, each trawl net that is rigged for fishing and has a mesh size less than 2.5", as measured between the centers of opposite knots when pulled taut, and each try net that is rigged for fishing and has a headrope length longer than 16.0 ft. must have a certified BRD installed. The following BRDs are certified for use by penaeid shrimp trawlers in the South Atlantic EEZ: extended funnel, expanded mesh and fisheye.

As of January 12, 2007, on a vessel that fishes for or possesses rock shrimp in the South Atlantic EEZ, each trawl net or try net that is rigged for fishing must have a certified BRD installed.

Turtle Excluder Devices (TEDs). TEDs are required for the peaneid and rock shrimp fisheries.

<u>Red Drum</u>
No harvest or possession is allowed in or from the EEZ (no gear specified).

<u>Golden Crab</u>
Crab traps (commercial). May not be fished in water depths less than 900 feet in the northern zone and 700 feet in the middle and southern zones. Rope is the only allowable material for mainlines and buoy line. Max. trap size = 64 cubic feet in volume in the Northern zone and 48 cubic feet in volume in the Mid and Southern zones. Traps must have at least 2 escape gaps or rings and an escape panel. Traps must be identified with a permit number.

<u>Coral, Coral Reefs, and Live/Hard Bottom Habitat</u>
Hand harvest only for allowable species (recreational and commercial). A toxic chemical may not be used or possessed in a coral area in the EEZ. A power-assisted tool may not be used to take prohibited coral, allowable octocoral or live rock.

Oculina Bank Habitat Area of Particular Concern: Fishing with bottom longlines, bottom trawls, dredges, pots or traps is prohibited. Fishing vessels may not anchor, use an anchor and chain, or use a grapple and chain.

<u>Coastal Migratory Pelagics</u>
Hook and line gear, usually rod and reel or bandit gear, hand lines, flat lines etc. (recreational and commercial).

Run-around gillnets or sink nets (commercial). A gillnet must have a float line less than 1,000 yards in length to fish for coastal migratory pelagic species. Gillnets must be at least 4-3/4 inch stretch mesh.

Purse seines for other coastal migratory species (commercial) with an incidental catch allowance for Spanish mackerel (10%) and king mackerel (1%).

For Atlantic king mackerel (commercial) north of the Cape Lookout, NC Light (34° 37.3' N. lat.) all gear is authorized except for drift gillnets and long gillnets. South of the Cape Lookout Light the following gear is authorized: **automatic reel, bandit gear, handline, rod & reel.**

For Spanish mackerel (commercial) **automatic reel, bandit gear, handline, rod & reel, cast net, run around gill net and stab net**. Minimum size of 3.5" stretch mesh required for all run around gill nets.

<u>Spiny Lobster</u>
Traps, hand harvest, dip nets and bully nets (recreational and commercial). No poisons or explosives are allowed. No spear, hooks or piercing devices are allowed. A degradable panel is required on non-wooden traps. Traps may not be tended at night. Buoy and trap identification is required.

<u>Dolphin and Wahoo</u>
Pelagic longline, hook and line gear including manual, electric, or hydraulic rod and reels, bandit gear, handline and spearfishing gear (including powerheads). Surface and pelagic longline gear for dolphin and wahoo is prohibited within any "time area closure" in the Atlantic EEZ which is closed to the use of pelagic gear for highly migratory pelagic species (HMS) (commercial).

<u>Sargassum</u>
Nets used to harvest Sargassum be constructed of 4" stretch mesh or larger fitted to a frame no larger than 4 x 6 feet.

6.2.2 Gear Descriptions

6.2.2.1 Mobile Gear

(from Barnette 2001)

Crab Scrape

A crab scrape is composed of a net bag attached to a rigid frame with short teeth (Figure 1). This gear, used exclusively in state waters, is dragged in the shallow water of bays and estuaries to catch crabs. There are no studies available that document potential damage to habitat. However, due to their design, their use in SAV would likely result in the potential uprooting of some plants, as well as leaf shearing (Barnette personal observations). However, crab scrapes are not typically employed in vegetated areas due to the amount of plant litter that would fill the net. Penetration of the benthos by the teeth would result in sediment resuspension.

Frame Trawl

Roller frame trawls 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 grip the bottom and turn freely. This motion prevents the scouring and scraping impacts primarily associated with otter trawls. Because participants in the fishery usually operate in shallow water, 9.14 m (30 ft) or less, frame trawls are typically limited to state waters.

A study by 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 uproot SAV. Damage to SAV beds was noted on several occasions when the boats ran aground. The study concluded that side frame trawls do negligible damage to SAV beds. This conclusion was supported by Meyer et al. (1991; 1999), who found no significant trawl impacts on shoot density, structure, or biomass with increased trawling on turtlegrass (*Thalassia testudinium*). However, these studies did not evaluate the effects of repetitive trawling.

Woodburn et al. (1957) noted that the roller on the bottom of the trawl does cause the leaves ripe for shedding to break off, though this would not negatively impact the plant itself. Higman (1952) concluded that frame trawling is not sufficient to denude vegetated areas permanently or to damage the ecology of such locations. Additionally, Tabb and Kenny (1967), while not explicitly investigating habitat impacts, believed that roller frame trawls do n o significant damage to habitat. 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 to 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 heavily damaged. The primary impact on *Sargassum* was that it was torn loose from the bottom resulting 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. It was concluded that frame trawls have a significant impact on certain benthic organisms (Tilmant 1979).

Furthermore, within dense SAV communities, removal of epibenthic algae, tunicates, sponges, and other primary producers may also be significant. Futch and Beaumariage (1965) recommended that the diameter of the rollers be no less than 15.2cm (6in) and that the teeth of the rakes on the trawls should not extend below the roller. Furthermore, they recommend that boats employed in the frame trawl fishery that operate in shallow water should be of tunneled construction to prevent damage to SAV from propeller scarring. Tabb (1958) recommended that strainer bars should be rigid and aimed into the roller so that regardless of how far forward the net frame tips, the bars cannot dig into the bottom. The results from Tilmant (1979) indicated that extensive damage occurs to hardbottom habitat from frame trawls.

A logical recommendation that can be extrapolated from this study is the prohibition of frame trawling in areas where hardbottom habitat exists. Frame trawls, while causing negligible damage to SAV, are not compatible with hardbottom areas due to the damage it causes to complex vertical habitat (e.g., sponges, corals, gorgonians).

Prohibition on the use of bottom trawls

The use of trawl gear to harvest fish in the directed snapper grouper fishery south of Cape Hatteras, North Carolina (35°15' N. Latitude) and north of Cape Canaveral, Florida (Vehicle Assembly Building, 28°35.1' N. Latitude) is prohibited (SAFMC 1987). A vessel with trawl gear and more than 200 pounds of fish in the snapper grouper fishery on board will be defined as a directed fishery. The amendment also establishes a rebuttable presumption that a vessel with fish in the snapper grouper fishery on board harvested its catch of such fish in the Exclusive Economic Zone.

The Council based the trawl prohibition on habitat destruction and the desire to prevent overfishing of vermilion snapper. Fishes present in live bottom areas are described by Grimes et al. (1982) and include 113 species representing 43 families of predominantly tropical and subtropical fishes. Vermilion snapper were more abundant on the shelf edge than on the open shelf (Grimes et al., 1982). Miller and Richards (1980) described the distribution of live bottom habitat in the South Atlantic Bight and reported the most productive area of the shelf for commercial reef fish as being in the open shelf zone between 33 and 40 meters. Parker et al. (1983) reported on a survey of the areas from Cape Canaveral, Florida to Cape Fear, North Carolina and from Cape Fear to Cape Hatteras, North Carolina. From Cape Hatteras to Cape Fear 14,486 square km between 27 and 101 m were surveyed and contained 2,040 square km (14%) of reef habitat of which only 204 square km (10%) had one meter or more relief (distance from the highest point of the live bottom to the ocean floor). In the area from Cape Fear to Cape Canaveral, 24,826 square km between 27 and 101 m were surveyed and contained 7,403 square km (30%) of reef habitat of which 1,743 square km (7%) had one meter or more relief. The Oregon II cruise report (Anon, 1978) supports the scattered nature of live bottom in the South Atlantic from Cape Canaveral, Florida to Cape Hatteras, North Carolina. The Fishery Management Plan reported that in terms of the entire shelf area, current data suggest that from three to 30 percent of the shelf is suitable bottom for snapper grouper species (SAFMC, 1983a).

The report on effects of a research trawl on live bottom (Van Dolah et al., 1987) documents that habitat damage does occur from the use of trawl gear even in the case of one pass through an area in a controlled study. The abstract is as follows:

"The effects of a research trawl on several sponge and coral species was assessed in a shallow-water, hard-bottom area located southeast of Savannah, Georgia. The study entailed a census of the numerically dominant species in replicate 25-m2 quadrants located along five transects established across a trawling alley. The density of undamaged sponges and corals was assessed in trawled and non-trawled (control) portions of each transect immediately before, immediately after, and 12 months after a 40/54 roller-rigged trawl was dragged through the alley once. Some damage to individuals of all target species was observed immediately after trawling, but only the density of barrel sponges (*Cliona* spp.) was significantly reduced. The extent of damage to the other sponges (*Ircinia campana, Haliclona oculata*), octocorals (*Leptogorgia virgulata, Lophogorgia hebes, Titanideum frauenfeldii*) and hard corals (*Oculina varicosa*) varied depending on the species, but changes in density were not statistically significant. Twelve months after trawling, the abundance of specimens counted in the trawled quadrants had increased to pre-trawl densities or greater, and damage to the sponges and corals could no longer be detected due to healing and growth. Trawl damage observed in this study was less severe than the damage reported for a similar habitat in a previous study. Differences between the two studies are attributed to (1) differences in the roller-rig design of the trawls used, and (2) differences in the number of times the same bottom was trawled."

The authors point out that in a study by Tilmant (1979) looking at the effects of commercial bait shrimping with roller-frame trawls in a shallow-water area of Biscayne Bay, Florida damage was much more severe: "Tilmant observed severe damage (specimens crushed or torn loose) to more than 80% of the stony corals, 50% of the sponges and 38% of the soft corals along the trawl path." It should be noted however, that this frame trawl consists of a solid, rectangular frame to which a net is attached and is used to fish grass bed areas; it was not designed to "roll over" live bottom and would be expected to cause significant damage to corals, etc.

Importantly, habitat damage described by Van Dolah et al. (1987) resulted from one tow of trawl gear through the study area. That study was designed to evaluate the effects of a research trawl that does not typically cross the same bottom area more than once. Commercial trawling does not operate in this manner. Under commercial fishing conditions, a live bottom area would be fished over and over until the catches from such an area become unprofitable. Under such conditions, habitat damage would be expected to be much greater than is indicated from the above study.

The *Oregon II* cruise report (Anon, 1978) indicated that drags with a trawl yielded a total catch of 476 pounds which included 424 pounds of finfish and 46 pounds of sponges and corals (10 percent of the total catch). This area was reported to have been on a mud bottom but turned out to be a low profile live bottom of sand ridges, clumps of sponges and scattered corals. Further indication of habitat damage is reported by Wenner (1983):

“The 3/4 Yankee trawl net effectively covers a much wider area of the bottom than the measured sweep (8.7 m) due to the configuration of the otter doors, ground cables, and bottom leg lines. Although this arrangement cannot increase the actual spread of the net beyond the headrope length, the passage of these cables over the substrate creates a disturbance that serves to herd fish in the path of the net (Baranov 1969). This net does, however, damage the sponge-coral habitat by shearing off sponges, soft corals, bryozoans, and other attached invertebrates. The 56 trawl tows made in the sponge-coral habitat for this study collected 2,351 kg of attached invertebrates (including sponges, soft corals, tunicates, bryozoans, and hydroids) yielding an average 42 kg/tow. This is only the amount of bottom material actually removed from the habitat. An estimate of the total amount of bottom destroyed by the doors, ground cables, and leg lines cannot be ascertained from the current study.

Personal observations and interviews with commercial fishermen attest to the productivity of the sponge-coral habitat. Most studies indicate the importance of habitat availability and space in determining the abundance and diversity of reef fishes (Emery 1978). With this in mind, and given the knowledge that 1) the use of the 3/4 Yankee trawl net reduces the amount of attached invertebrate growth (the amount damaged by doors and ground cables is presently not quantifiable); 2) the places where the invertebrates had been attached may be sanded over and rendered unsuitable for recolonization; and 3) the removal of these attached invertebrates reduces refugees for decapods, polychaetes, etc., that are food items for *Centropristis striata* and other benthic feeders, one must conclude that the continued use of this trawl net reduces the amount of productive fish habitat. For these reasons, in addition to the ineffectiveness of the gear in sampling commercially important species, alternate nondestructive methods, such as direct observations or the use of mark-recapture techniques with trap catches, should be employed in assessment surveys of the commercially important species of this habitat.”

Results of trawl survey work in Australia provide some insight into what can happen to catches in an area after the continued use of commercial trawl gear. Young and Sainsbury (1985) report that "At moderate to low levels of fishing effort, the main effect of fishing on the relative abundance of bottom shelf fishes is by alteration of the relative frequency and spatial distribution of habitat types. In particular this refers to the conversion of areas with dense epibenthos (sponge, corals, hydroids, gorgonians) to areas with sparse epibenthos. (It may be noted that even at the relatively low intensity of trawling of the past few years the fishing effort exerted on the main trawl grounds is sufficient to sweep 50 to 100 per cent of the area of those grounds per year.)." These results are from trawling conducted in 1982 as compared to trawl catches in 1966 from the same locations and at the same time of year. The catch composition shifted from species associated with sponges, soft corals, etc. (during 1966) to those associated with open sandy bottom (during 1982).

A similar type of scenario for the South Atlantic was suggested by Bob Low (pers. comm.):

“Parker et al. (1983) estimated that, in the area they surveyed between Cape Fear and Cape Canaveral, there were 7,403 square km of reef habitat. Of this, 1,743 square km had an average profile exceeding 1 m. Assuming that such ground could not be trawled, this leaves about 5,660 square km (1,398,000 acres) of trawlable reef habitat. The average boat might pull a net with a footrope of 120 feet, giving an effective sweep of the roller gear of about 72 feet maximum. A typical tow over open bottom is perhaps 3 hours at 2 knots. The area swept by the roller gear per tow is then about 20 acres/hour or 60 acres/tow. Assume that 20 boats participate for 4 months (January-April) each year. [Note: The actual number of vessels during 1987 was seven.] The average vessel makes 3 trips/month, with 3 days of fishing each trip. The average (24 hr) fishing day includes perhaps 4 tows. A typical trip therefore consists of 12 tows or 36 hr of fishing. The 20 boats make an aggregate of 240 trips. This equates to 2,880 tows, covering around 172,800 total acres. If each tow was over a previously unswept area, the total area covered by the roller gear would then amount to about 12% of the trawlable reef habitat estimated by Parker et al. (1983). Under one set of assumptions, the area affected by the doors, bridles, and warps would add to this. Under a second set, repetitive trawling over identical areas would reduce the total area impacted. Van Dolah et al. (1987) noted a substantial renewability within a year. There are likely to be 8 months of recovery time between trawling seasons. Doesn't that allow for significant restoration in many of the trawled areas?”

The above scenario indicated that about 12 percent of available habitat between Cape Fear and Cape Canaveral would be impacted annually by trawling, whereas in the Australian work the area impacted was between 50 and 100 percent. The Council has concluded that the level of damage to the live-bottom habitat in the South Atlantic is significant and that our available knowledge is not sufficient to risk impacting the long-term abundance of snapper and groupers by reducing their habitat. The results shown by Van Dolah et al. (1987) indicated that regeneration of tissue sufficient to have rounded off the tops of partially severed sponges and to have closed wounds on other sponges occurs within a year but that additional growth is limited as indicated by some of the sponges being obviously shorter than before the trawling damage. This supports the Council’s concern because in a four month trawling season there would be a net loss of habitat (i.e., more damage than regrowth) with the effects being cumulative over time. By destroying habitat we destroy the productivity of the resource being harvested and we are in essence drawing on the principal, not just taking the interest so that next year the same amount of trawling will represent more than 12 percent of the habitat and the year after even more. Given this information, the South Atlantic Fishery Management Council concluded that over the long-term there would be a net loss of existing habitat, which is counter to the Council's habitat policy and the Magnuson Act.

Indirect evidence of habitat damage is provided in Christian et al. (1985) where they report on attempts to use crab nets rigged with light chain and plastic mud rollers. These nets proved to be inadequate for offshore fish trawling on broken bottom because the light molded plastic mud rollers were not durable and did not prevent net damage. They further reported that captains who tried crab nets soon switched to nets with heavy netting, properly rigged sweep systems and steel vee-doors for trawling over rough bottom. Further indication of habitat damage was presented in Section II of Snapper Grouper Amendment 1 with the numerous references to gear damage, gear loss and the need to use rollers and modified doors to be able to trawl in rough and broken areas.

An additional reference concerning potential habitat damage is provided by Moore and Bullis (1960) when they reported on the discovery of a deep water reef in the Gulf of Mexico. The MV *Oregon* was cruising over the continental slope about 40 nautical miles due east of the Mississippi Delta and observed an unusual tracing on the depth recorder. They sampled this bottom area using a shrimp trawl and reported the following: "A drag, made over the area with a shrimp trawl, contained a large mass of coral, other invertebrates, and fish. The netting of the trawl was torn and most of its contents were lost, but about three hundred pounds of coral remained in the bag. A sample was brought back to the laboratory where it was identified by Moore as *Lophelia prolifera*."

Invertebrates associated with sponges and corals occur in disproportionately high densities which suggest that they may use sponges and corals as a food source or a refuge from predation (Wendt et al., 1985). These invertebrates in turn serve as a food source for various snapper and grouper species. In addition, corals are very slow growing with some such as *Oculina* sp. only growing between 11 and 16 mm per year (Reed, 1981). Damage to these areas can negatively affect the food and shelter available to snappers and groupers. Further, Grimes et al. (1982) note the importance of the live bottom and shelf edge habitats in serving as reservoirs for recruits in shallow areas (less than 30 m).

The best estimate of the number of boats operating in the fishery during the winter of 1986/87 was four boats (one South Carolina boat fishing in South Carolina and three North Carolina boats fishing in South Carolina, Georgia and Florida). The number of vessels increased to seven during the winter of 1987/88. These vessels fished during the slow period for shrimp which is normally January to March/April. Even though the actual number of boats is small, the amount of habitat damage is significant when one realizes that these boats fish directly on the limited live bottom habitat in these areas. Productive snapper grouper habitat on the continental shelf is limited and trawl gear is fished repeatedly in these areas over this three to four month period. Most, if not all, fishermen use Loran which allows them to return to the exact spot and trawl a particular rock out-cropping repeatedly. The data previously described from Australia points out the changes to bottom habitat and catches resulting from such a fishery.

Vermilion snapper in the early 1980s were experiencing growth overfishing (see SAFMC 1983a p. 44-58 for a more detailed discussion). Yield per recruit (or yield per individual) analysis indicated that a 12 inch minimum size will increase yield per recruit from 132 g to 177 g which is equivalent to a 34 percent increase in yield if recruitment is constant. Confidential data available to the South Atlantic Council indicated that the minimum mesh size of 4 inches is not being adhered to and as a result the Council's prior action establishing the mesh restriction has not been effective in releasing small vermilion (less than 12 inches). The trawl prohibition will result in an increase in yield for vermilion snapper. Catch data from South Carolina (Bob Low, pers. comm.) show a slight negative correlation between trawl landings and hook & line landings (r = -0.13). A good fishery independent index of abundance would allow us to examine the affect of trawl catches on abundance of vermilion snapper. Given the available information, the South Atlantic Fishery Management Council concluded that the trawl prohibition would increase yield; however, our ability to measure this increase is lacking.

The potential existed for more vessels to enter the fishery particularly if the calico scallop, shrimp and sea scallop fisheries have not been productive or are not active during this time period. The actual number of vessels during 1987/88 was seven, greater than the number expected. This further supported the Council's concern that effort could have increased rapidly.

Impacts on affected vessels from prohibiting use of trawl gear in the snapper grouper fishery were not significant. Input from public hearings, committee and Council meetings indicated that income from fish trawling made up a small portion of total income. No trawl fishermen came forward with information during the public hearing process indicating that impacts would be significant. Fishermen used this fishing method primarily as a fill-in activity and had the ability to utilize other gear (e.g. electric & hydraulic reels, black sea bass traps, longlines, etc.) to fish snappers and groupers. These general conclusions are supported by the following in Christian et al. (1985):

"The major seafood industry in the South Atlantic Bight is based on shrimp, and this dependence on one crop has made the industry financially precarious. ... Therefore, fishermen have looked to other activities such as bottom trawling for finfishes to supplement their income. This is not the single salvation for the whole industry. Although fish trawling can offer an alternative which may aid some shrimpers in maintaining year-round income, suitable trawling bottom in this area is limited, and target species of such a fishery (snapper, grouper, and porgies) are relatively long-lived, slow-growing, and can sustain only limited fishing pressure."

Hydraulic Escalator Dredge

Hydraulic escalator dredges have been utilized since the 1940s to harvest shellfish such as clams and oysters and are designed expressly for efficient commercial harvest (Coen 1995). The dredge consists of a water pump supplying a manifold with numerous water jets mounted in front of a conveyer belt that dislodges buried organisms from the sediment (Figure 3). Hydraulic escalator dredges are currently only employed in a limited shellfish fishery in South Carolina state waters. Hydraulic escalator dredges may penetrate the benthos approximately 45.7cm (18in), thus disturbance to the sediment may be substantial (Coen 1995). Increased turbidity, burial/smothering, release of contaminants, increased nutrients, and removal of infauna were offered as potential effects from dredging activities (Coen 1995). Turbidity was found to be elevated only in the immediate vicinity of the harvester operation and downcurrent of the study area to a distance of between 1.5 - 1.75km. Turbidity values returned to baseline levels within a few hours (Maier et al. 1998). Manning (1957) stated that hydraulic clam dredging can result in severe damage to oysters within a distance of 7.6m (25ft) downcurrent from the site of dredging. Enough sediment was displaced and redeposited to a distance of at least 15.2m (50ft), but not more than 22.9m (75ft) downcurrent, to cause possible damage to oyster spat. Beyond about 22.9m (75ft) there was no visible or measurable change in the experimental area. Sediment plumes caused by dredge activity were found by Ruffin (1995) to range from less than 1 to 64 hectares. Although sediment plumes increased turbidity and light attenuation at all depths, plumes in shallow water (<1.0 m) caused greater increase in turbidity and light attenuation over background than did plumes in deeper waters. Plume decay is based largely on sediment size, with sand particles settling quickly while the silt/clay particles remain in suspension longer. Sites were monitored for storm disturbance to compare against dredge impacts. Storm events increased turbidity and light attenuation com pare d to calm days but not to the extremes obtained in sediment plumes.

Storm events affect a large area at a low intensity while dredging intensely affects a more localized area. SAV subjected to decreased light penetration will inhibit reproduction, reduce propagule abundance, and structurally weaken SAV due to the need of plants growing higher into the water column (Ruffin 1995). Ruffin (1995) concluded that clam dredging increased light attenuation to the point of inhibiting SAV growth. As may be expected, hydraulic clam dredges are highly destructive t o SAV within the immediate area of intensive dredging (Manning 1957; Godcharles 1971). Due to the capability of the water jets to penetrate the substrate to a depth of 45.7cm (18in), virtually all attached vegetation in its path is uprooted (Godcharles 1971). As the u se of this gear is limited to a fishery in South Carolina where SAV does not exist, discussion of SAV impacts are included only to provide information on potential impacts should this gear type be considered in the future for other geographic area s where SAV may be found. Although there may be physical impacts associated with escalator dredge activity, the chemical effects apparently are not as dramatic. Dissolved oxygen, pH, and dissolved hydrogen sulfide were measured throughout the harvesting process at varying distances. No consistent patterns of depression or release were noted. Only in the direct plume of the harvester did they measure even a temporary reduction in dissolved oxygen and pH (Coen 1995). While it is recognized that there is infaunal and epifaunal species mortality associated with escalator dredge activity, based on all evidence, these community impacts appear to be short-term (Godcharles 1971, Peterson et al. 1987a, Coen 1995). Coen (1995) noted that the escalator possibly provides a tilling effect of the bottom that has been observed to be beneficial to subtidal oyster and clam populations. Typically, shellfish dredging operations have typically not been considered to have deleterious results, since its effects are perceived to be negligible compared to natural environmental variation (Godwin 1973). Coen (1995) concluded that based on all direct and indirect evidence, the short-term effects of subtidal escalator harvesters are minimal, with no long-term chronic effects, even under worst case scenarios. Observed effects were often indistinguishable from ambient levels or natural variability.

Recovery of the benthos may vary greatly depending on sediment composition. Shallower trenches with shorter residency times are typical of coarse sediments (i.e., sand), whereas trenches generated in muddy, finer sediments are typically deeper, often persisting for greater than 18 months (Coen 1995). Godcharles (1971) observed that trenches had filled in between 1 to 10 months, depending on bottom type. In regard to SAV, no trace of *Thalassia testudinium* recovery was evident after more than 1 year, though *Caulerpa prolifera* began to re-establish itself in dredge areas within 86 days (Godcharles 1971).

Otter Trawl

Perhaps the most widely recognized and criticized type of gear employed in the Southeast Region is the otter trawl. Utilized in both state and Federal waters of the Gulf of Mexico and South Atlantic, otter trawls pursue invertebrate species such as shrimp and calico scallops, as well as finfish species such as flounder and butterfish. As the most extensively utilized towed bottom-fishing gear (Watling and Norse 1998), trawls have been identified as the most wide-spread form of disturbance to marine systems below depths affected by storms (Watling and Norse 1998; Friedlander et al. 1999).

Jones (1992) broadly classified the way a trawl can affect the seabed as: scraping and ploughing; sediment resuspension; and physical habitat destruction, and removal or scattering of non-target benthos. The following discussion attempts to group documented impacts into either physical-chemical (e.g., sediment resuspension, water quality) or biological impact categories. In many instances documented habitat impacts overlap these categories.

<u>Physical-Chemical Repercussions</u>

The degree to which bottom trawls disturb the sediment surface depends on the sediment type and the relationship between gear type, gear weight, and trawling speed (ICES 1991). Various parts of trawl gear may impact the bottom including the doors, tickler chains, footropes, rollers, trawl shoes, and the belly of the net. While the components of trawl gear are similar, trawl design m ay vary greatly. Potential impacts may be shared by all otter trawls, but differences in the weight of trawl doors, footrope design, and operation (tow times), will result in a broad spectrum of impact severity. Furthermore, the number and weight of tickler chains vary the degree of disturbance: Margetts and Bridger (1971) concluded that the cumulative effect of tickler chains is likely to emulsify the sediment to a depth proportional to the number of chains. Additionally, the cumulative effect of intense otter trawling is as important as gear weight and design in impacting the benthos (Ball et al. 2000). Although the effect of one passage of a fishing (trawl) net may be relatively minor, the cumulative effect and intensity of trawling may generate long-term changes in benthic communities (Collie et al. 1997). Trawl gear disturbs the benthos as it is dragged along the bottom. Otter trawl doors, mounted ahead and on each side of the net, spread the mouth of the net laterally across the sea floor. The spreading action of the doors results from the angle at which they are mounted, which creates hydrodynamic forces to push them apart and, in concert with the trawl door's weight, also to push them toward the sea bed (Carr and Milliken 1998). The doors, due to their design and function, are responsible for a large proportion of the potential damage inflicted by a trawl. The footrope runs along the bottom of the net mouth and may be lined with lead weight and rollers. On relatively flat bottom, it is expected that the footrope would not have a major effect on the seabed and its fauna (ICES 1995). However, in areas of complex benthic habitat the footrope would likely have more impact with the benthos.

The South Atlantic Draft Calico Scallop FMP noted that during the early years of the calico scallop fishery, large quantities of benthic material were removed by trawlers. Reports were received during numerous meetings about entire “rocks” being removed. One individual provided a print-out from a depth sounder which indicated a large amount of bottom relief in a particular area prior to the calico scallop fishery. Similar bottom plots after the calico scallop fishery operated in that area indicated a relatively flat bottom (S AFMC 1 998b). Additionally, while the footrope generally causes little physical substrate alteration aside from smoothing of bedforms and minor compression on relatively flat bottoms (Brylinsky et al. 1994), these minor compressions can lead to sediment “packing” after repeated trawling activity on the same general areas Schwinghammer et al. 1996; Lindeboom and de Groot 1998). Further compression can result from the dragging of a loaded net (cod end) along the bottom. The remaining path of the trawl is influenced by the ground warps which, while not in direct contact with the seabed, can create turbulence that resuspends sediment (Prena et al. 1999).

Trawl gear, particularly the trawl doors, penetrates the upper layer of the sediments which liquefies the affected sedimentary layers and suspends sediment in the overlying water column. This sediment “cloud” generated by the interaction of the trawl gear with the benthos and the turbulence created in its wake contributes to fish capture (Main and Sangster 1979; 1981). The appearance of the sediment cloud, but not its size, is governed by the type of seabed. Brief observations on different seabed types show that soft, light-colored mud produces the most opaque and reflective type of cloud and the fine mud remains in suspension much longer than coarse sand. Studies of sediment disturbance by trawls vary greatly, though it can be concluded that benthic habitat areas composed of fine sediments (e.g., clay, mud) are affected to a greater degree than those with coarse sediments (e.g., sand). In sandy sediments, otter boards cannot penetrate deeply due to the mechanical resistance of the sediment, and the seabed in sand y areas is more rapidly restored by waves and currents (DeAlteris et al. 1999). Short-term alterations to sediment size distribution result from the various rates of redeposition of suspended sediments; as noted before, coarse grains (i.e., sand) settle out rapidly while fine grains (i.e., silt) settle out relatively slowly. In general, resuspended sediments settle out of the water column at a rate inversely proportional to sediment size (Margetts and Bridger 1971). Transport of fine-grained sediments away from trawled area s due to this slow settling period may result in permanent changes to the sediment grain size of a trawled area. Again, this effect will be more pronounced in mud/silt habitats than in habitat areas consisting of heavier sand. For example, suspended sediment concentrations of 100-500mgl-1 were recorded 100m 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 25-209,000,000m^3, which is 10-100 times greater than the amount dredged during the same period for maintenance of shipping channels in the same area.

ICES (1973) concluded that the physical effects of trawling in tidal waters cannot be permanent. However, it is possible that frequently repeated trawling of one ground with a mixed sediment type bottom in strongly tidal waters might ultimately alter the nature of the bottom towards being predominantly coarse sand because the finer particles are carried away to settle elsewhere. In deeper waters, impacts may be more profound and longer lasting. Engel and Kvitek (1998) investigated two adjacent areas in 180m of water to determine the differences between a heavily trawled site and a lightly trawled site. The data indicated that intensive trawling significantly decreased habitat heterogeneity. Rocks and mound s were less common and sediments and shell fragments were more common in the highly trawled area. Rocks and mounds were more abundant in the lightly trawled area, as well as the amount of flocculent matter and detritus. They theorized that less trawling most likely results in an area with more topographical relief and allows for the accumulation of debris, whereas consistent trawling removes rocks, smoothes over mounds, and resuspends and removes debris. Likewise, Kenchington (1995) found that sand ripples were flattened and stones were displaced after a trawl passage. Churchill (1989) modeled sediment resuspension by trawling and found that this may be a primary source of suspended sediment over the outer shelf where storm-related bottom stresses are weak.

Otter trawl doors were found to have a maximum cutting depth of 50 - 300mm (Drew and Larsen 1994) and, according to Schubel et al. (1979), the footropes of shrimp trawlers in Texas disturbed approximately the upper 50mm of the sediment. Schwinghamer et al. (1996) observed that while the trawl doors may leave scours or depressions, trawling activity reduces the overall surface roughness. Ripples, detrital aggregations, and surface traces of bioturbation are smoothed over by the mechanical action of the trawl and the suspension and subsequent deposition of the surface sediment. In general, the passage of an otter trawl was found to have a minor physical and visual impact on the soft sedimentary sea bed, represented by a flattening of the normally mounded sediment surface and some disturbance of the sessile epifauna (Lindeboom and de Groot 1998). The potential to suspend sediments varies greatly, in large part due to the type of sediment a trawl is working on. Regardless, the suspension of sediments, whether fine silt or coarse sand, impacts the chemical and physical attributes of water quality. The resuspension of sediments may influence the uptake or release of contaminants and, depending on the frequency of disturbance, the nature of the contaminant(s). Clearly, such effects may be more significant where contaminant burdens are relatively high, e.g., near areas affected b y major industrialization (ICES 1995). Repetitive trawling on the same ground may enhance nutrient release from sediments and that estimates of average trawling effort for large areas may be unsuitable for estimating these effects (ICES 1995). This has important implications on nutrient cycling in areas that are regularly trawled. Pilskaln et al. (1998) found that impacts include burial of fresh organic matter and exposure of anaerobic sediments; large nutrient delivery to the water column, possibly impacting primary production; increase in nitrate flux out of the sediments; and reduced denitrification (conversion of remineralized nitrogen into N2 gas). All of these may have desirable or undesirable ecosystem impacts. An increase in nitrate fluxes to the water column may alter primary production (phytoplankton), potentially benefiting fisheries, or stimulating deleterious phytoplankton growth that results in harmful algal bloom s (Pilskaln et al. 1998).

Increased water turbidity as a result of trawling activity has the potential to compress the width of the euphotic zone, wherein light levels are sufficient to support photosynthesis

(North Carolina Division of Marine Fisheries 1999). The magnitude of this effect depends on sediment size, duration and periodicity of the trawling event, gear type, season, and site-specific hydrographic and bathymetric features (Paine 1979; Kinnish 1992).

Dredging studies would indicate that the effect of turbidity is greatly dependent on local conditions. Windom (1975) found that sediment resuspension caused by dredging operations significantly reduced phytoplankton growth in a naturally clear estuary (South Florida) but not in a naturally turbid estuary (Chesapeake Bay). Additionally, increased turbidity resulting from trawling activities may reduce primary production of benthic microalgae. This may have serious consequences as benthic microalgae support a variety of consumers and can be a significant portion of total primary production (Cahoon and Cooke 1992; Cahoon and Tronzo 1992; Cahoon et al. 1990; 1993). Increased turbidity also has may reduce the foraging success of visual predators (Minello et al. 1987) an d contribute to the mortality of organisms by impeding the normal functioning of feeding and respiratory structures (Sherk et al. 1975). Sediment resuspension may increase the amount of organic matter resulting from enhanced primary production and may stimulate heterotrophic microbial production. If the amount of resuspended organic material is copious, sustained proliferation of heterotrophic microflora will reduce the dissolved oxygen content within the water, and widespread hypoxia or anoxia could ensue to the detriment of benthic and pelagic faun a (West et al. 199 4). Conversely, oxygen penetration into the sediment might be enhanced through trawling activity, resulting in shifts in mineralization patterns and redox-dependent chemical processes. Among other consequences, a change from anaerobic to aerobic conditions facilitates the degradation of hydrocarbons. As Kaiser (2000) pointed out, bottom trawls are designed to stay in close contact with the seabed and an inevitable consequence of their design is the penetration and resuspension of the seabed to some extent. While it is possible to reduce the direct physical forces exerted on the seabed b y modifying fishing practices, the benefits are questionable and catches would most certainly suffer. Despite attempts to improve gear design, as long as bottom dwelling species are harvested using towed gear, there will be inevitable sediment resuspension.

Biological Repercussions

The physical disturbance of sediment, such as the ones previously discussed, can also result in a loss of biological organization and reduce species richness (Hall 1994). In general, the heavier the gear and the deeper its penetration of the sediment, the greater the damage to the fauna. Impacts also will vary depending on type of habitat the gear is working. Gibb s et al. (1980) determined that shrimp trawling occurring within a sandy estuary had no detectable effect on the macrobenthos. After repeated trawls the sea bottom appeared only slightly marked by the trawl's passage. However, Eleuterius (1987) noted that scarring due to shrimp trawls in Mississippi SAV w as common, especially in deeper water. Trawling activities left tracks and ripped up the margins of the beds, and great masses of seagrass were often observed floating on the surface following the opening of shrimp season. Furthermore, Wenner (1983) noted that the use of an otter trawl on hardbottom habitat may inflict considerable damage. The net damages the sponge-coral habitat by shearing off sponges, soft corals, bryozoans, and other attached invertebrates. Therefore, it is not necessarily that trawl gear is doing a constant level of damage, but rather particular habitats are more vulnerable to impacts than others.

Numerous studies cite specific, direct biological impacts to habitat such as the reduction of algal and SAV biomass (Tabb 1958; Fonseca et al. 1984; Bargmann et al. 1985; Peterson et al. 1987a; Sánchez-Lizaso et al. 1990; Guillén et al. 1994; Ardizzone et al. 2000). Gelatinous zooplankton and jellyfish, which provide habitat to juvenile and other fish species, are greatly impacted as they pass through the mesh of mobile gear (Auster and Langton 1999). Fishing activity may reduce the size and number of zooplankton aggregations and disperse associated fishes. Furthermore, there is a directed trawl fishery for cannonball jellyfish in the Gulf of Mexico.

While this fishery removes jellyfish which may provide habitat for juvenile fish, otter trawls utilized in this fishery do not interact with the benthos. Trawls in the Gulf of Mexico and South Atlantic have been noted to impact coral habitat, damaging and destroying various colonies (Moore and Bullis 1960; Gomez et al. 1987; Bohnsack personal observation). Loss of sponges and associated cnidarian benthos has been documented to lead to a reduction in fish catch (Sainsbury 1988; Hutchings 1990). Sponges are particularly sensitive to disturbance because they recruit periodically and are slow growing in deeper waters (Auster and Langton 1999). Bradstock and Gordon (1983) observed that trawling virtually destroyed large areas dominated by encrusting coralline growths (bryozoans), reducing colony size and density. Probert et al. (1997) documented the bycatch of benthic species that occurs in a deep-water trawl fishery and noted the vulnerability of pinnacle communities and deepwater coral banks such as the Oculina habitat area of eastern Florida. Van Dolah et al. (1983; 1987) conducted experimental trawl surveys over hard bottom habitat consisting of coral and sponge off the coast of Georgia. A single pass of an otter trawl on this habitat damaged all counted species (Van Dolah et al. 1983; 1987).

However, only the density of barrel sponges was significantly decreased by trawling activities. It should be noted that these studies did not investigate the cumulative impacts of trawls. The repetitive effects of trawling over the same area can be expected to have more severe consequences to benthic habitat. While Moran and Stephenson (2000) estimated that a demersal otter trawl reduced benthos (>20cm in maximum dimensions) density by 15.5% in a single pass, Cappo et al. (1998) estimated that complete denuding of the sea bottom structure occurs after 10-13 trawl passes over the same area. Of equal importance are the observations of Moran and Stephenson (2000), who noted variations among trawl studies, possibly due to differences of employed ground ropes. These variations are a warning against generalizations about the impact of otter trawls on attached benthos. As many epifaunal and infaunal organ isms create structures which provide habitat for other species, summaries of these studies and their findings are included. For example, many infauna species and other bioturbators have an important role in maintaining the structure and oxygenation of muddy sediment habitats. Consequently, any adverse effects on these organisms would presumably lead to changes in habitat complexity and community structure (Jennings and Kaiser 1998). Furthermore, the loss of biogenic epifaunal species (epibenthic habitat) increases the predation risk for juveniles of other species, thereby lowering subsequent recruitment to adult stocks (Bradstock and Gordon 1983; Walters and Juanes 1993; Jennings and Kaiser 1998). Therefore, reduction in biomass of epifaunal species may be considered a reduction or degradation of habitat in certain instances and trawling has been documented to decrease mean individual biomass of epibenthic species (Sainsbury et al. 1993; Prena et al. 1999). While it may be hard to quantify the impact this loss presents to habitat-dependent organisms, it should be noted nonetheless. In a long-term study of Corpus Christi Bay, Texas, Flint and Younk (1983) noted that the continual minor and random disturbance, both in time and space, of channel sediments by large tanker traffic and shrimp trawling probably was sufficient to keep these communities in a state of constant disruption. This allowed the opportunists to persist more successfully than other species. The disturbed channel sites of the study, though viable, consistently had lower densities, lower numbers of species and corresponding low diversities contrasted to the lesser impacted shoal sampling sites (Flint and Younk 1983). Engel and Kvitek (1998) investigated two adjacent areas in 180 m of water to determine the differences between a heavily trawled site and a lightly trawled site.

They concluded that high-intensity trawling apparently reduces habitat complexity and biodiversity while simultaneously increasing opportunistic infauna and the prey of some commercial fish. The data indicated that intensive trawling significantly decreased habitat heterogeneity. All epifaunal invertebrates counted were less abundant in the highly trawled area. Bergman and Santbrink (2000) estimated direct mortality on various species of benthic megafauna from a single pass of an otter trawl (sole fishery) at between 0 - 52% for silty sediments and between 0 - 30% for sandy sediments. In general, small-sized species tend to show lower direct mortalities, when compared with larger sized species and smaller individuals of megafaunal species tend to show lower mortalities than larger-sized ones. Krost and Rumohr (1990) noted damage directly resulting from otter trawl doors. Benthic organisms were found to be reduced in number by 40 to 75% in otter board tracks, as compared to control sites. Biomass was also generally reduced. However, they found almost no differences in epibenthic species such as crustaceans. In shallow areas with densely packed sediments, inhabitants of the upper sediment layer were found to suffer most by the trawling impact.

In contrast to the above studies, there are several studies that document no significant habitat impact. Van Dolah et al. (1991) found no long-term effects of trawling on an estuarine benthic community; five months of shrimp trawling in areas previously closed to fishing were found to have no pronounced effect on the abundance, diversity, or composition of the soft bottom community when compared to nearby fished areas. They concluded that seasonal reductions in the abundance and numbers of species sampled had a much greater effect than fishing disturbance. In a power analysis of their sampling strategy, Jennings and Kaiser (1998) noted that Van Dolah et al. (1991) only considered changes in the abundance of individuals and the number of species. This assumes that the response of the infauna to trawling disturbance was unidirectional, whereas a consideration of changes in partial dominance might have been more sensitive to subtle changes in the fauna. Yet, Jennings and Kaiser (1998) stated that the results of Van Dolah et al. (1991) were plausible and that light shrimp trawls probably do not cause significant disturbance to communities in poorly sorted sediments in shallow water. Sanchez et al. (2000) determined that sporadic episodes of trawling in muddy habitats may cause relatively few changes in community composition. They found similar infaunal community changes in both fished and unfished control areas through time. Sanchez et al. (2000) also noted that the decrease in the abundance of certain species in the unfished control areas may indicate that the natural variability at the experimental site exceeds the effect s of fishing disturbance. Regardless, Ball et al. (2000) commented that epifauna are generally scarce in muddy sediment habitats, and detection of fishing effects on such species has therefore been limited.

While the passage of a trawl may damage or destroy macroinfauna, Gilkinson et al. (1998) suggested that smaller infauna are resuspended or displaced by a pressure wave preceding otter trawl doors and are redeposited to the sides of the gear path. Due to a buffer effect caused by a displacement field of sediment (sand), bivalves incur a low level of damage (5%) by the passing of a trawl door. In contrast to coarse sediment communities where the infauna are found within the top 10 cm, organisms in so ft mud communities can burrow up to two meters deep (Atkinson and Nash 1990). Due to their depth, it is likely that these organisms are less likely impacted by passing trawls (Jennings and Kaiser 199 8), though it should be noted that the energetic costs of repeated burrow reconstruction may have long-term implications for the survivorship of individuals.

Studies documenting impacts to habitat from successive trawling are not prevalent. However, a few studies suggest that shifts in species abundance and diversity are a result of the cumulative effects of trawling. Over a longer time scale (i.e., 50 years), Ball et al. (2000) suggested that fishing disturbance may ultimately lead to an altered, but stable, community comprising a reduced number of species, and hence, diversity. Sainsbury et al. (1993; 1997) noted that composition of a multispecies fish community in Australia was at least partially habitat-dependent and that historical changes in relative abundance and species composition in this region were at least in part a result of the dam age inflicted on the epibenthic habitat by the demersal trawling gear. In summary, 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. It should also be 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 (Pitcher et al. 2000). Yet, several studies indicate that trawls have the potential to seriously impact sensitive habitat areas such as SAV, hardbottom, and coral reefs. In regard to hard bottom and coral reefs, it should be recognized that trawlers do no t typically operate in these area s due to the potential dam age 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. 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). However, 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. Regardless, 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.

Recovery of substrate depends on sediment type, depth, and natural influences such as currents and bioturbation. Schoellhamer (1996) investigated sediment resuspension within Tampa Bay, a shallow estuary with fine non-cohesive material (muds absent), and found that sediment concentrations returned to pre-trawl conditions approximately 8 hours after disturbance. The cumulative effects of several trawlers operating were not investigated. DeAlteris et al. (1999) found that scars similar to those that occur from otter trawl boards disappear relatively quickly in a shallow sand environment, while those occurring in a deeper mud habitat took as long as two months to disappear. DeAlteris et al. (1999) also found that natural disturbances to mud substrate in 14 m of water are rarely capable of disturbing the seabed. Therefore, recovery of fishery-related impacts in deeper water may be protracted due to the lack of natural events that help deposit sediments and fill trawl scars. Ball et al. (2000) determined that intensive demersal trawling over muddy seabeds leads to apparent long –term alteration of the seabed. Trawl tracks in muddy sediments may last up to 18 months; however, in areas of strong tidal or wave action, they are likely to disappear rapidly. Also, in areas w here levels of bioturbation are high, and regular turnover of sediment produces large numbers of mounds on the seabed, trawl tracks will be filled relatively quickly (Ball et al. 2000). Habitats in deeper water tend to recover at a slower rate. Berms and furrows generated by trawl doors generally disappeared within one year in sandy habitats in depths of approximately 120-146 m (Schwinghamer et al. 1998; Prena et al. 1999). More dramatic is t he estimate of 5 0-75 years to fill a typical trawl mark (~15 cm scour depth) in deep water (>175m) by Friedlander et al. (1999). The greater the water movement, the faster the scars will be filled in (Jones 1992). Churchill (1989) and Krost et al. (1990) reported an increase in the frequency of tracks attributed to trawl doors in deeper water, presumably where water movement and natural impacts are less pronounced.

In general, few studies document recovery rates of habitat. Those that do investigate recovery usually only do so after a single treatment which does not reflect the reality of fishing impacts which are ongoing and cumulative. For example, Van Dolah et al. (1983; 1987) noted that hard bottom habit at in h is trawl study recovered within one year. However, the experiment did not investigate the cumulative and repetitive effects of trawling at commercial intensities. As noted by an ICES (1995) study, due to the cumulative effects of trawling, focus on the scale of individual trawl impacts may be in adequate for estimating the importance of impacts on benthic communities. ICES (1994) stated that deep water coral banks (e.g., *Oculina varicosa*), due to their fragility, long life spans, and infrequent recruitment, may be nearly exterminated by a single passage of a trawl an d are unlikely to recover "within a foreseeable future." Likewise, SAV would also have a protracted recovery time in comparison to sediments. SAV recovery may vary by species and can be greater than two years if the rhizomes of the plant are removed (Homziak et al. 1982). Regardless, the majority of studies concur that shallow communities have proved to be resilient due to their adaptation to highly variable environmental conditions and thus, recovery is usually swift. Kaiser et al. (1996 a) found epifaunal communities in 35m of water that were experimentally trawled were indistinguishable from control sites after six months.

In areas of low current or great tidal exchange (e.g., deep ocean), where the benthos is not adapted to high sediment loads, the adverse effects of sediment resuspension by gear could persist for decades (Jones 1992). Recovery of small epibenthic organisms may be relatively rapid, but recovery of larger epibenthic organisms would be expected to be much slower. Though they did not discuss depth as a controlling factor, Sainsbury et al. (1993; 1997) indicated that there would be a considerable time lag after trawling ceases before recovery of large epibenthic organisms is substantial. Boesch and Rosenberg (1981) predicted that recovery times for macrobenthos of temperate regions would be less than five years for shallow waters (including estuaries) and less than ten years for coastal areas of moderate depth.

The majority of management recommendations indicate that marine reserves or gear zoning may be the most effective at reducing habitat impacts. However, other specific recommendations can be extracted from several studies. Tabb (1958) recommended that otter trawls not be permitted to operate in the bait shrimp fishery due to potential impact to SAV communities. Van Dolah et al. (1987) suggested that trawls with doors attached directly to the nets would greatly reduce the bottom area damaged by trawling activities. The use of artificial reefs to protect the seabed, in particular along the perimeter of SAV habitat areas, from trawling has also been offered (Guillén et al. 1994; Ardizzone et al. 2000). The use of semi-pelagic trawls would avoid the majority of habitat impacts that demersal trawls are associated with. However, while the use of semi-pelagic nets does not significantly impact the benthos, catch efficiency m ay be greatly reduced.

Furthermore, enforcement on the use of semi-pelagic nets remains difficult (Moran and Stephenson 2000). Carr and Milliken (1998) offered more straightforward recommendations: target certain species and modify gear appropriately; encourage the use of lighter sweeps; reduce the sea bottom available to trawlers that fish very irregular terrain; and o pt for stationary gear over mobile gear. It is suggested that where fishing effort is constrained within particular fishing grounds, and where data on fishing effort are available, studies that compare similar sites along a gradient of effort have produced the types of information on effort impact that will be required for effective habitat management (Collie et al. 1997; Auster and Langton 1999). Additionally, the use of an indicator species (e.g., quahogs) that provides a historical record of fishing disturbance events could greatly enhance the interpretation of perceived changes ascertained from samples of present-day benthic communities (Macdonald et al. 1996; Kaiser 1998). Finally, the use of tracking devices (VMS) would provide a means for identifying the most heavily fished areas and those, if any, that are presently unfished (Macdonald et al. 1996; Kaiser 1998).

Comprehensive mapping of benthic habitats may provide the necessary information to determine what areas are at risk from fishery-related impacts. Utilized in conjunction with information that details fishing effort and area, gear zoning that limits the vulnerability of sensitive habitats while minimizing economic impacts to fishery participants should be considered.

Oyster Dredge

An oyster dredge 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, as well as the South Atlantic. 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 in the height of natural oyster reefs is expected to be less than that of re store d 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. Regardless, it is likely that the height of natural reefs is also reduced by dredging because a large portion of extracted material from natural reefs by dredges is shell matrix. Lenihan and Peterson (1998) stated that it was probable that reduction in reef heights in a Neuse River, North Carolina estuary was due to decades of fishery-related disturbances caused by oyster dredging. 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 the seasonal bottom-water hypoxia/anoxia which 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 Peters on 1998). 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 resulted in the removal of the productive layer of shell and oyster, leaving 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. Fished areas were found to be softer and have less odor of decomposition than the unfished control site. Glude and Landers (1953) also found a decrease in benthic fauna in the fished sites versus the unfished control sites. Conversely, a study conducted by Langan (199 8) which looked at the impacts oyster dredging had o n benthic habitat, as well as sediment resuspension resulting from dredging activity, concluded with different results. He noted that the size-frequency of oysters from the control site was biased towards older and larger specimen s 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. It should be note d that the stud y failed to evaluate fishing activity (number of participants, effort) on the dredged site.

Due to overfishing and disease, oysters may now be more economically valuable for the habitat they provide for other valued species than they are for the oyster fishery (Lenihan and Peterson 1998). Rothschild et al. (1994) suggested the establishment of broodstock sanctuaries that includes the designation of “no-fishing” restrictions in specific areas. Lenihan and Micheli (2000) also recommended the closure of some oyster reefs to harvest. Maintaining high densities of oysters on some intertidal reefs may help to preserve future oyster harvests and broodstock. Furthermore, protecting some reefs will also preserve the ecological functions that oyster reef provide such as improving water quality and providing essential recruitment, refuge, and foraging habitat for numerous marine species.

Scallop Dredge (Inshore)

Scallop dredges are similar to crab scrapes, though scallop dredges utilized in the Southeast generally do not have teeth located on the bottom bar. Scallop dredges are predominately used on SAV beds where bay scallops can be efficiently harvested, and thus, are primarily limited to state waters. Popular bay scallop fisheries exist both off Florida and North Carolina. This gear, while similar, is not the same type of dredge utilized offshore to harvest calico scallops (*Argopecten gibbus*) or Atlantic sea scallops (*Placopecten magellanicus*).

Though scallop dredges do not have teeth that would easily uproot SAV, studies have noted a reduction of algal and SAV biomass from their use (Fonseca et al. 1984; Bargmann et al. 1985). The reduction of SAV (*Zostera marina*) biomass was linearly related to the number of times a particular area was dredged, and the effects of dredging were proportionately greater on soft bottom than hard bottom (Fonseca et al. 1984). The Fonseca et al. (1984) study utilized an empty dredge that was 60% of the legal limit for a commercial dredge, and was not employed in conjunction with a boat as the commercial fishery does. Hand dredging was done to eliminate propeller scour which commonly occurs in shallow SAV beds. In commercial scalloping, the added dredge and scallop weight, as well as the propeller wash, could be expected to have a greater imp act (Fonseca et al. 1984). In general, more damage from scallop dredging occurred to SAV in soft substrates (i.e., mud) than hard substrates (i.e., sand). In softer sediments, plants were uprooted and damage to underground plant tissues, including meristems, occurred. In harder sediments, damage was found to be generally greater for above ground parts; underground meristems were left intact and able to begin to repair shoots or produce new ones after impacts had ceased (Fonseca et al. 198 4).

Fonseca et al. (1984) determined that in a lightly harvested SAV area, with <25 % biomass removal, recovery occurred within a year. In areas where harvesting resulted in the removal of 65% of SAV biomass, recovery was delayed for two years. After four years, pre harvesting biomass levels were still not obtained. These estimates were based on termination of fishery-related impacts. Continued fishing activity would likely lead to prolonged recovery and continued degradation. Homziak et al. (1982) estimated that SAV recovery can be greater than two years if the rhizomes of the plant are removed.

Due to the importance of SAV beds as a nursery area to other species, loss of eelgrass meadows should be avoided. Fonseca et al. (1984) suggested that harvest area rotation may minimize habitat impact.

Scallop Dredge (Offshore)

Scallop dredges (Figure 7) utilized to harvest calico or sea scallops consist of a metal frame that supports tickler chains and a metal ring bag that collects the shellfish. Though not widely utilized in the Southeast, the gear has been included in this review due to their inclusion as an approved gear in the South Atlantic. The majority of studies on scallop dredge impacts originate from areas with extensive scallop fisheries such as the northwest and northeast Atlantic.

Due to the potential for the g ear to have considerable weight and the fact that it is dragged along the bottom, habitat impacts are expected to occur. Drew and Larsen (1994) estimated that a scallop dredge maximum cutting depth would be 40 - 150mm. Kaiser et al. (1996a) found that scallop dredging greatly reduced the abundance of most species, causing significant changes in the community. It was noted that a large proportion of some animals (such as echinoderms) were not captured or passed through the mesh of the gear. The scallop dredge catches contained a low proportion of non-target species which indicates that the belly rings allow the bycatch to escape. However, the study did not investigate the extent of damage/injury to organisms that were not captured. Likewise, Collie et al. (1997) found areas on Georges Bank that were impacted by scallop dredges to have lower species diversity, lower biomass of fauna, and dominated by hard-shelled bivalves, echinoderms, and scavenging decapods. Areas less impacted by dredges had higher diversity indices. However, it should be noted that portions of Georges Bank consist of cobble habitat which is encrusted with a diverse array of epibenthic species.

Perhaps more applicable to the areas in the Southeast where calico scallops are harvested off North Carolina and Florida, would be a study conducted by Butcher et al. (1981), who determined that scallop dredges had little or no environmental effect when they were used on large-grained, firm sand bottom that was shaped in roughly parallel ridges. The area in this study was also noted to be a fairly uniform, low species diversity community. Turbidity caused by the turbulence of the dredge quickly dissipated due to the nature of the substrate. Additionally, Jolley (19 72) found no detrimental dredging effects on s and substrates. Yet, there is a potential for dredges to impact coral adjacent to scallop beds, especially the scallop grounds which occur in close proximity to the Oculina Bank off eastern Florida. Should a scallop dredge impact *Oculina* coral, there would be severe results, similar to the conclusion s reached by ICES (199 4) for trawls. This study determined that deep water coral banks such as those com posed of *Oculina varicosa*, due to their fragility, long- life spans, slow growth, and infrequent recruitment, may be nearly exterminated by a single passage of a trawl. Recovery of this habitat area, "within a foreseeable future," is unlikely (ICES 1994).

Skimmer Trawl

Skimmer trawls are positioned along the side of a boat and pushed through the water to harvest shrimp. Two nets are typically used, one on each side of the boat. Skimmer trawls 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. Because of the construction attributes of this gear type, skimmer trawls are generally restricted to water 3.05m (10 ft) or less which would limit them to state waters.

Skimmer trawls work on mud bottoms in water generally 3.05m (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. However, skimmer trawls are expected to impact the bottom less than otter trawls due to the absence of doors (Nelson 1993; Steele 1993). Coale et al. (1994) believed that the skimmer trawl would not have any greater effects on SAV than the otter trawl. They found it doubtful that the inside weight and outer shoe of the skimmer trawl would cause greater detrimental effects to the benthos than the heavy doors of an otter trawl. Based on underwater observations, Coale et al. (1994) suggested that the weight and shoe combination may be less-damaging than otter trawls. However, habitat such as sponges and SAV are cut off by tickler chains and lead lines whereas otter trawl doors can dig in and tear up the bottom. Given the difference in the amount of area covered by each on normal tows, Kennedy, Jr. (1993) found it doubtful that there would be much difference in the amount of habitat loss between skimmer trawls and otter trawls.

Kennedy, Jr. (1993) recommended that the use of skimmer trawls in Florida should be restricted to those areas currently approved for otter trawls. Due to the associated impacts to SAV, a prudent recommendation would be to limit skimmer trawl use to non-vegetated substrates.

6.2.2.2 Static Gear

Channel Net

Channel nets are fixed to pilings, docks, or shore installation and utilize current flow to capture shrimp, therefore, channel nets are limited to use within state waters. Though impacts of channel nets were not discussed specifically, it may be inferred from Higman (1952) that channel nets have negligible impact on habitat due to catch composition and the lack of interaction with the benthos.

Gillnet and Trammel Net

Gillnets (Figure 9) consist of a wall of netting set in a straight line, equipped with weights at the bottom an d floats at the top, and is usually anchored at each end. As fish swim through the virtually invisible monofilament netting, they become entangled w hen 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 is made up of two or more panels suspended from a float line and attached to a single lead line. The outer panel(s) are of a larger mesh size than the inner panel. Fish swim through the outer panel and hit the inner panel which carries it through the other outer panel, creating a bag and trapping the fish. Smaller and larger fish become wedged, gilled, or tangled. Gillnet s are widely used in numerous fisheries, both in state waters and in Federal waters. Trammel nets are primarily used in state waters, though they are an authorized gear in the Caribbean for both the spiny lobster and shallow water reef fish fisheries.

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; ICES 1995; Kaiser et al. 1996b). An ASMFC (2000) report determined that impacts to SAV from gillnets would be minimal. Likewise, West et al. (1994) stated that there was no evidence that sink net (gillnet) activities contributed importantly to bottom habitat disturbance. However, Carr (1988) noted that ghost gillnet s in the Gulf of Maine could become entangled in rough bottom. He observed one net that had its leadline and floatline twisted around each other and tightly stretched between boulders. Furthermore, Williamson (1998) noted that gillnets can snag and break benthic structures. Gomez et al. (1987) noted that gill nets set near reefs occasionally results in accidental snaring often resulting in damage to coral. Bottom set gillnets have led to habitat destruction in different regions (Jennings and Polun in 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 (Öhman et al. 1993). This observation has also been noted in a study by Munro et al. (1987), which documented that reefs are frequently damaged by the hauling of set (gill) nets, and the problem has been exacerbated by the use of mechanical net haulers or power blocks. 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 incorporated by marine species. Cooper et al. (1988) found ghost gillnets in the Gulf of Maine covered with a heavy filamentous growth, exceeding 75% coverage on some nets. Anemones, stalked ascidians and sponges were attached to and growing to the net float lines (Carr et al. 1985; Cooper et al. 1988). Erzini et al. (1997) found that lost trammel nets and gill nets in shallow water (15-18m) on rocky habitat (analogous to coral reefs and hard bottom habitat) were colonized by various species, primarily macrophytes, which after three months completely blocked the meshes of some parts of the nets. Some netting would contact reef habitat, becoming heavily overgrown and eventually blended into the background. After a year, most of the netting was destroyed; those remnants that remained were completely colonized by biota (Erzini et al. 1997). Erzini et al. (1997) also 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 which was attractive to many organisms. For example, large schools of juvenile fish were often observed in the vicinity of these heavily colonized nets, which 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 better substrate for marine growths and there by attract fish and other predators which may get entangled, ultimately causing the net to sink. Therefore, one may assume that gillnets may be more of a ghostfishing problem and entanglement hazard to marine life than as an impact to habitat.

Catch by entanglement nets during 1988 was 1,398 pounds from North Carolina through Georgia (less than 1% of the combined state catch) and 253,739 pounds from the Florida East Coast (6% Florida East Coast catches). Much of the Florida landings are from a directed stab net fishery for gray snapper that operates in the EEZ. The Gulf Council and the State of Florida have prohibited entanglement nets. Florida regulations read as follows: "No person shall harvest in or from state waters any snapper of the family of Lutjanidae or any member of the genera *Epinephelus* or *Mycteroperca* by or with the use of any gear other than those types of gears specified in SubSection 1, provided however that snapper and grouper harvested as an incidental bycatch of other species lawfully harvested with other types of gears shall not be deemed to be unlawfully harvested in violation of this section, if the quantity of snapper/grouper so harvested does not exceed the bag and possession limits as specified elsewhere." The South Atlantic Council's actions track the Florida regulations in intent with respect to limiting possession to the bag limit and for species without a bag limit, no possession is allowed. Florida prohibited entanglement nets because it is an inappropriate gear to use on live bottom. Some of the reef fish are not necessarily found on the live bottom, however, many are and fishermen use stab nets to catch gray snapper on the live bottom areas.

The Council has concluded that entanglement nets are not an appropriate gear for the snapper grouper fishery and the prohibition will prevent use and/or expansion from North Carolina through Florida's East Coast. Entanglement nets targeting species other than those included in the management unit are limited to the bag limit if the species is under a bag limit, and if no bag limit is applicable, then no retention is allowed.

SAFMC Prohibition on the Use of Entanglement Nets

Snapper Grouper Amendment 4 prohibits the use of entanglement nets including, but not limited to, gill nets and trammel nets, for the harvest of species in the snapper grouper management unit (SAFMC 1991a). The simultaneous possession of entanglement nets and species in the management unit is prohibited.

Hoop Net

A hoop net is a cone-shaped or flat net which may or may not have throats and flues stretched over a series of rings or hoops for support. The net is set by securing the cod or tapered end to a post or anchored to the bottom. The net is played out with the current until fully extended, and then is allowed to settle to the bottom. The net is marked with a buoy for easy retrieval and identification purposes. The duration of time that a hoop net is set depends on the same factors that influence the duration of the set of a gill net and should be determined in a similar fashion. To harvest, the hoop net is raised at the cod end and the fish are removed.

While there are no studies that document the effect of hoop nets on habitat, due to its use primarily on flat bottoms the gear probably has less of an impact than traps.

Longline

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 12) in areas too rough for trawling or to target reef associated species, or set adrift, suspended by floats (Figure 13) to target swordfish and sharks. Longlines are widely utilized in numerous fisheries throughout the Southeast Region.

When a vessel is retrieving a bottom longline it may be dragged across the bottom for some distance. The substrate penetration, if there is any, would not be expected to exceed the breadth of the fishhook, which is rarely more than 50mm (Drew and Larsen 1994). More importantly 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.

Bottom longlines in the snapper grouper fishery

The Council prohibited the use of bottom longline gear for snapper grouper in the South Atlantic EEZ within 50 fathoms (SAFMC 1994). Catch by bottom longlines during 1988 was 470,306 pounds from North Carolina through Georgia (6% of the combined state catches) and 576,310 pounds from the Florida East Coast (13% Florida East Coast catch). The Council was concerned about the use of bottom longline gear targeting species in the snapper grouper management unit in live bottom areas. Habitat damage and intense competition among users are problems that arise when this gear is used within 50 fathoms where significant live bottom occurs and where competition with hook and line vessels occurs. The Council concluded that this gear is appropriate for use in the deep-water snowy grouper/tilefish fishery where much of the bottom is mud with sparse live bottom areas. Allowing use of this gear deeper than 50 fathoms would preserve the traditional fishery which takes place in deeper water out to 50 fathoms. Based on information from South Carolina, up until 1983 the snapper grouper fishery was limited to vertical hook and line or bandit reels. Bottom longlines were introduced in the Gulf of Mexico after hook and line gear became less effective due to decreases in resource abundance; use of the gear grew rapidly. Up until this point there has been no gear prohibition on bottom longlines. After the golden tilefish and snowy grouper fisheries were developed, bottom longlines became the predominant gear, again as resource abundance declined. For species like snowy grouper and tilefish, it was not very efficient to use vertical hook and lines as the resource abundance declined from unfished levels. As the tilefish and snowy grouper stocks off South Carolina declined, the number of people using longlines decreased. Off South Carolina virtually all of the golden tilefish occurred well outside the 50-fathom mark and there was more than enough gear to adequately harvest these resources in the mid-depth zone. Vertical lines are much more environmentally acceptable and less damaging than bottom longlines.

This regulation essentially segments the mid-shelf and the deep-water complex to the bottom longlines. This measure was supported during the public hearing process and the Council concluded that prohibiting use of longline gear within 50 fathoms will prevent the problems of habitat damage and intense competition while at the same time allow fishermen using this gear to continue fishing in deeper water. This action effectively limits longlines to targeting the deep water component of the snapper grouper fishery and keeps the use of longlines outside of the rough bottom habitat.

The Council very briefly considered moving the line in to the 40 fathom contour but was concerned that there are substantial Oculina coral banks along this depth zone. It was further noted that the 50 fathoms was a compromise from the 100 fathom contour (which was mentioned) and that the 50 fathom contour effectively separates the inshore and deep water snapper grouper complexes.

Impacts on habitat
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 light weight 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 (50ft) or more on either side of the hooked fish. Based on these observations, it is logical to assume that longline gear would have a minor impact to sandy or muddy habitat areas. However, due to the vertical relief that hardbottom and coral reef habitats provide, it would be expected that longline gear may become entangled, resulting in potential impacts to habitat. Due to a lack of interaction with the benthos, pelagic long lines would have a negligible habitat impact.

SAFMC Prohibition on the Use of Bottom Longlines
The Council prohibits bottom longlining in the wreckfish fishery in the entire South Atlantic EEZ (SAFMC 1991a). A bottom longline is a stationary, buoyed, and anchored

groundline with hooks attached. Regulations prohibit simultaneous possession of wreckfish and all the necessary components for bottom longlining.

The Council was concerned about wastage of fish, gear loss, gear conflict, habitat damage, and negative economic effects (both short and long run) attributable to the use of bottom longline gear in the wreckfish fishery. The bottom habitat on the wreckfish fishing grounds, which comprise an area of the Blake Plateau of approximately 50-75 square nautical miles, is characterized by a rocky ridge system having a vertical relief greater than 50 meters and a slope greater than 15° (SAFMC 1993). The depth range in this area is 450-600 meters; the substrates in areas of the Blake Plateau exhibiting significant relief are generally characterized as composed of manganese phosphate pavements, phosphorite slabs and coral banks (Pratt and McFarlin, 1966; Stetson et al, 1969). This high relief, in conjunction with the strong tidal effects, makes gear loss probable (as reported by fishermen who have already tried longlines in the wreckfish fishery) which results in the loss of all fish on the gear as well as those which get hooked subsequently. Testimony from fishermen indicated gear loss on wreckfish longline sets was as great as 100% of the gear taken out on a single trip. According to accounts from fishermen, extensive lengths of lost longline gear have been observed on their fathometers. Fishermen can apparently see fish hooked on parted longline gear but are unable to recover the parted gear and its catch. Wreckfish fishermen use circle hooks that virtually prevent fish from working the hook free. The Council recognized that there was also some ghost fishing potential from lost vertical gear but believes that the extent of potential loss with vertical gear is much smaller by virtue of the fewer number of hooks used and the greater control over the gear.

Although the area is 50-75 square nautical miles, virtually all wreckfish fishing takes place along limited, high relief ledge areas within this area because wreckfish are found along the ledges and are not evenly distributed over the wider area. The sub-areas that produce wreckfish are typically 300 yards wide and 1 - 4 nautical miles long. Thus far, fishermen fishing vertical drop gear have been able to work in relatively close proximity without any major conflicts. If bottom longlines had been allowed to be used in this area, vessels would have not only lost gear due to the rough bottom, but this lost gear would create a hazard for those using vertical lines which would result in loss of that gear. This problem would have become progressively worse over time as more gear was lost, the more hangs were created for both longline and vertical gear, creating even more gear loss. This condition could have continued until much of the ground is unfishable. The wire cable that is used will remain a hazard for many years as the rate of decay is slow. While extensive hangs may ultimately provide protection for the resource due to much of the fishing grounds being unfishable, it may well result in the loss of the fishery. The use of longlines will result in gear losses to vertical hook and line fishermen that far exceed their losses prior to the introduction of longlines. This will serve to reduce benefits to those fishing with the traditional vertical gear.

The potential for gear entanglement and gear conflict also raised the issue of vessel safety. It was the Council's opinion that this situation would have lead to conflicts that jeopardize the safety of the vessels and fishermen participating in the wreckfish fishery.

Longline cable on the bottom has the potential to break some of the ledges, overhangs and associated organisms, and otherwise damage the habitat on which the wreckfish depend. Habitat damage caused by the longlines would violate the SAFMC habitat policy and should be avoided.

The wreckfish fishery has employed efficient vertical gear since its inception, and the addition of longlines would have eroded benefits to the majority of fishermen and adversely impact the resource and habitat. If longlines had been allowed, then all or at least many wreckfish fishermen may have been forced to adopt the gear in order to compete resulting in more gear loss from parted longlines. The Council determined that bottom longlines were not in the best interest of the wreckfish resource, habitat, fishermen or society at large. Further, the problems outlined justified prohibiting this gear/fishing method in the wreckfish fishery.

Poundnet

A pound net consists of a fence constructed of netting that runs perpendicular to shore which directs fish to swim voluntarily into successive enclosures known as the heart, pound, or pocket. Pound nets are exclusively utilized in state waters.

An ASMFC (2000) report determined t hat impact s to S AV from pound nets are expected to be minimal, unless the net is constructed directly on SAV. West et al. (1994) also stated that pound nets do not contribute to benthic disturbance. Due to the limited amount of space a pound net ma y impact, it is expected that pound nets have minimal impact on habitat.

Trap and Pot

Traps and pots 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 to 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. Wire-mesh fish traps are one of the principal fishing gears used in coral reef areas in the Caribbean (Appledorn 2000).

Traps are inexpensive, easily constructed, easy to use and require little skill (although the most successful fishing depends on skill in locating productive fishing grounds), fish unattended, catch a wide range of species not caught by other gear, allow economic exploitation of low density fish stocks, allow fishing where other methods are uneconomical or have become uneconomical because of overfishing and are able to be fished over a wide range of depth, bottom types and conditions. On the other hand, traps are bulky, result in trap loss and ghost fishing, catch species that were not traditional food fish, are fished near live bottom causing habitat damage, result in a bycatch of which a portion dies upon release, result in gear and user group conflict, and existing regulations are extremely difficult or impossible to enforce.

Due to their use to harvest species associated with coral and hard bottom habitat, traps and pots have been identified to impact and degrade habitat. Gomez et al. (1987) noted the incidental breakage of corals on which traps may fall or settle constitute the destructive effects of this gear. Within the Virgin Islands State Park, Garrison (1998) found 86% of the fish traps were set on organisms (live coral, soft coral, SAV) living on the sea floor. Damage to the live substrate has far-reaching negative effects on the marine ecosystem because the available amount of shelter and food often decreases as damage increases. Another study conducted by Garrison (1997) had similar results, as 82% of traps rested directly on live substrate, with 17% resting on stony corals.

Hunt and Matthews (1999) found that lobster and stone crab traps reduce the abundance of gorgonian colonies from rope entanglement. Furthermore, seagrass smothering occurs from trap placement on SAV beds, resulting in SAV "halos." Van der Knapp (1993) noted that fish traps set on staghorn coral easily damaged the coral. 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. The greatest impact noted from the setting of traps was observed when the point of the trap's frame ran into coral formations. Several different species of coral were observed to suffer damage from fish traps. Observations of at least one damaged coral specimen noted that algae growth prevented regeneration in the damaged portion of the coral. Additionally, complete deterioration of a vase sponge was observed after it had been severely damaged by a trap. Traps are not placed randomly, rather they are fished in specific areas multiple times before fishing activity moves to other grounds. Therefore, trap damage has a concentrated cumulative effect in particular areas rather than be uniform over all coral reef habitat

Appledorn 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, either directly or through subsequent algal overgrowth or disease infection. During initial hauling, a trap may be dragged over m ore 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 recovery is orders of magnitude greater than the cumulative area of the traps themselves. Appledorn 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. Of the traps investigated in the study, 44% were set on hard bottom or reef, resulting in 23% damage to coral colonies (70 cm^2 average), 34% damage to gorgonian colonies (56 cm^2 average), and 30% damage to sponges, though sponges were less frequently impacted due to their patchy distribution. Trap hauling resulted in 30% of the traps inflicting additional damage to the substrate. In a similar study focusing on fish trap impacts conducted off St. Thomas, U.S.V.I., by Quandt (1999), 40% of all traps investigated were found to be resting on reef substrate. On average, 4.98% of all hard corals and 47.17% of all gorgonians were damaged; tissue damage averaged 20.03% to each gorgonian. Secondary impacts, such as trap hauling and movement due to natural disturbances were not investigated. However, the effects of pulling a string of two or more traps would most likely be much greater than one trap alone.

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 were lying flat on the seabed. When the pot was removed, the sea pens were able to reestablish themselves in the sediment. A species o f sea fan also was found to be flexible and specimens were not severely damaged when pots were hauled over them. 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. Additionally, 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.

Trap loss and ghost fishing

Gear failure, theft, and improper placement are several of the many reasons why fish traps are lost both inshore and offshore. Gear failure can occur because of pot warp (line) parting, buoys separating from the pot warp, or buoys breaking up. Normal wear and tear, powerboat propellers, and sea turtles or sea gulls biting the buoys or pot warp can cause gear failure. Theft is also a major cause of lost traps in many areas. Losses also occur because of setting the traps too deep or on too steep a slope. Storm surge and wave action can cause loss of traps, particularly in shallow inshore waters. Traps without buoys are less susceptible to storm damage, but may be moved from a site by currents or wave action and become irretrievable. In coralline areas, the buoy lines may become entangled on coral, chafe, and break. Offshore, losses are primarily caused by large vessels cutting or dragging gear, gear failure, and storms. Strong currents submerging buoys or sweeping traps away from the locations where they were set and traps becoming entangled with other fishing gear and anchors have also been cited as causes of trap loss.

The percentage of traps lost varies considerably among studies by both area and depth fished. Wolf and Chislett (1974) reported pot losses of 10-20% per trip in exploratory efforts in deep water shelf edges in the Virgin Islands. They attributed these losses to pots tumbling down steep slopes. Craig (1976) reported a trap loss rate of about 20% for a period of six months with some loss due to theft while trap fishing off Boca Raton, Florida. In Broward County, Florida, trap fishermen reported an average of 20.3% annual loss due mainly to strong currents, entanglement and theft. Dade County, Florida trap fishermen reported losing 1-5 traps per trip, with an annual loss of 100%. Losses were due to theft or loss of buoys. Trap theft was such a problem that traps were brought back to port at the end of each fishing day in Dade (Sutherland and Harper, 1983). Monroe County, Florida trap fishermen had estimated average annual trap losses of 63%. The losses were mainly from currents and severance of buoys by large ships in deep water and from vandalism inshore. Trap loss was not a problem in Collier County, Florida with an annual loss of only 5% due to the fact that fishermen brought back traps to the dock after each trip (Taylor and McMichael, 1983). About 85% of traps used off Key Biscayne, Florida were lost with most losses attributed to theft (Sutherland et al., 1987). Trap loss from theft and severed fouling lines was reported as a major problem in the Virgin Islands (Swingle et al., 1970; Olsen et al., 1974; Sylvester, 1972).

In Jamaica, Munro and Thompson (1973) had such a theft problem in their study that the use of buoyed traps had to be abandoned. Losses due to theft, storms, and vessels cannot easily be controlled, but trap fishermen can inspect gear frequently for wear and tear and use more durable materials.

Fish traps that fishermen cannot locate and retrieve or that are abandoned but are still capable of catching fish, are referred to as ghost traps. Ghost traps have long been a subject of concern, but opinions have changed considerably over time. Since Olsen et al. (1978) made their observations that if traps were lost, juvenile and forage species mortality could decimate a fishing ground, they suggested that considerable mortality could take place over the 1-2 years before the mesh corroded away, and indicated corrosion time would be longer and mortality would be greater for small sizes of mesh. A study by Harper and McClelland (1983) estimated the average fishing life of eight traps observed off Key Biscayne to be from 5.5 to 157 days before becoming unable to capture fish. They also found that 19.2% of the fish that entered the trap died (Harper and McClelland, 1983). While the decay and catch rates of ghost traps are not well documented, at least some evidence indicates that lost traps quickly become damaged and ineffective (Sutherland et al., 1978). Most reports of injury and mortality from ghost traps are anecdotal but underwater video presented to the South Atlantic Fishery Management Council on June 11, 1990 documented dead and injured fish in ghost traps in the Florida Keys. The video was presented by Fernand Braun in an effort to persuade the Council to ban fish traps.

Derelict traps are lost or abandoned traps that are incapable of catching fish due to structural damage or deterioration. Derelict traps may have small holes or breaks in the wire mesh, gaps between ceiling and floor panels and walls, or entire panels degraded or missing (Smolowitz, 1978). Traps become derelict in a number of ways. Predator damage, wire mesh corrosion, escape windows opening, and materials fastened to escape devices decomposing have all been documented.

Munro et al. (1971) speculated that lost traps that have accumulated large numbers of fish may be attacked and rendered ineffective by large predators such as nurse sharks

(*Ginglymostoma cirratum*). Harper and McClelland (1983) found funnel openings enlarged with the prongs bent back and speculated that the damage was by large predators such as cubera snapper (*Lutjanus cyanopterus*), great barracuda (*Sphyraena barracuda*), yellow jacks (*Caranx bartholomae*), and lemon sharks (*Negaprion brevirostris*) attempting to escape and that mortality of these fish was high Craig (1976) found that escapement through trap holes caused by predators became a problem if traps were not hauled after five or six days. Fish are rarely caught in traps with holes or breaks in the mesh and even small holes or breaks in the wire mesh apparently render them ineffective (Craig, 1976; Sutherland and Harper, 1983; Ward, 1983).

Sutherland et al. (1983) found juvenile fish numerous in and around derelict traps. The derelict traps and other man made objects appeared to serve as artificial reefs on barren sand sea floor areas (Sutherland et al., 1983; Harper and McClelland, 1983). Sutherland et al. (1983) observed that fish were absent or rare near traps on or adjacent to reefs.

Impacts on habitat

The Council concluded that the issue of traps is a critical issue to the State of Florida and in the long term to the entire South Atlantic as well. Florida deliberated the issue of traps for many years and the Florida State Legislature prohibited the use of fish traps in 1980. There have been many problems since then due to the inconsistency between state and federal regulations. The snapper grouper resource off the Florida Atlantic coast has continued to decline. The snapper grouper stocks are more overfished off Florida than they are anywhere else in the South Atlantic.

The Council concluded that if they cannot prohibit fish traps, they will never be able to stop overfishing of the snapper grouper resource. The Council concluded that traps are non-selective by size and by species (e.g., red grouper recruit to the hook and line fishery at around 19" and to the trap fishery at around 11"). Bohnsack et al. (1989) do note that modifications to mesh size will alter the size of fish caught. They noted that total value, species caught, number of individuals and mean total weight per haul declined with meshes larger or smaller than 1.5" hexagonal mesh. The mesh sizes required to correlate with the 20" minimum sizes would be so large as to result in de facto prohibition on use of fish traps.

Traps unnecessarily kill an abundance of tropical fish because they harvest angelfish, tangs, parrotfish, etc. The Council has based this conclusion on input from commercial and recreational fishermen and from processors and dealers. In addition, information contained in Bohnsack et al. (1989) document the catch of these species. Unfortunately, these species were not recorded separately in the commercial landings data until recently, thus the commercial landings data are not available to quantify the extent to which catches of these species have increased.

Since March 1, 1991 the State of Florida has prohibited the harvest of tropical fish: "The purpose and intent of this Chapter is to protect and conserve Florida's tropical marine life resources and to ensure the continued health and abundance of these species. The further intent of this Chapter is to ensure that the harvesters in this fishery use non-lethal methods of harvest and that the fish, invertebrates and plants so harvested be maintained alive for the maximum possible conservation and economic benefits." Allowing fish traps in federal waters would make Florida's regulations difficult, if not impossible, to enforce and would not address Problem #5 which is, that "the existence of inconsistent state and federal regulation makes it difficult to coordinate, implement and enforce management measures and may lead to overfishing. Inconsistent management measures create public confusion and hinder voluntary compliance."

The way in which fish traps were used made enforcement extremely difficult. All other kinds of fishing gear are eventually brought back to the dock where they can be examined by state marine patrol officers or other law enforcement personnel. Once traps are placed in the water, they were seldom are brought back to the dock. Testimony documents the various kinds of violations recorded in the Key West area (e.g., biodegradable panel requirement violations). The loss of traps was high ranging from 20% to 63% and in certain sectors trap loss may be as high as 100%.

The SAFMC Law Enforcement Committee and Advisory Panel were established to advise the Council on enforceability of various management approaches. They noted that the existing system is difficult to enforce and is incompatible with Florida state law, that the 100-foot contour limitation is difficult to enforce and that poaching is a big law enforcement problem in the fish trap fishery. These two bodies recommended to the Council that a total prohibition on use of fish traps in the South Atlantic EEZ was the most enforceable of all alternatives considered.

The enforcement issue was summarized by Kelley (1990): "Enforcement is the largest problem of all. There are widespread abuses of the regulations governing the use of fish traps. There seems to be no effective way to enforce regulations in a fishery, such as trap fishing, where gear can't be observed readily by enforcement officials. The largest present day problems in the Florida Keys and South Florida are the extensive trap poaching and the use of illegally constructed or deployed traps." In addition, Officer Gordon Sharp (a Florida Marine Patrol officer in Key West) presented information at public hearings and Council meetings indicating the great difficulty in enforcing existing regulations and noted a large number of violations of existing regulations.

The Council recognized that gear that is not brought back to shore at the end of a fishing trip makes enforcement extremely difficult. The Council considered other, less drastic measures that would allow traps to be used but concluded that the at-sea enforcement required to effectively monitor and ensure compliance with existing regulations does not and will not exist. Therefore, the Council was persuaded that nothing short of a total ban would be enforceable.

Continued use of such highly efficient gear in a stressed fishery is no longer biologically tolerable. Thirteen of 27 snapper grouper species identified in Amendment 4 are documented as overfished with Spawning Stock Ratios (SSRs) of less than 30%. Although insufficient data are available to determine SSRs for the remaining 15 species, they are also thought to be overfished. From a socioeconomic perspective, continued use of fish traps will result in a small group of fishermen removing a disproportionate share of the available fish, thus precluding their use by all other user groups at best and at worst leading to overfishing.

There is evidence that fish trapping causes habitat damage where fish traps are set in trawls on live bottom and where grappling hooks are dragged across live bottom to retrieve them. Testimony and video records of damaged *Oculina* reefs off Palm Beach County, provided to the Council at the February 1991 meeting, depicted significant and measurable damage to coral reef and live bottom communities. These activities leave an imprint of the trap upon the bottom communities and trenches caused by grappling hooks dragged over the bottom for the purpose of locating and recovering traps. Lost traps not only continue to fish, as it has been pointed out in the ghost trap discussion, but may contribute considerable secondary habitat damage by becoming mobilized at times of storm activity and impacting delicate bottom communities. These problems cannot be alleviated by trap design modifications even if such modifications could be enforced.

The affect of selective removal of herbivores on the health of coral reefs was discussed by LaPointe (1989). These species were harvested by fish traps more frequently than by hook and line gear. Again, due to the fact that commercial statistics did not record these fish by species, data was unavailable to document the level of harvest by fish traps or by hook and line.

Prohibiting fish traps was determined to be consistent with Florida's Coastal Zone Management Plan. Also, internationally, a number of countries (e.g., Bermuda) have tried to manage fish trap gear only to end up prohibiting their use. Bermuda has managed their snapper grouper fishery for a number of years and imposed a limited entry system with trap limitation. In addition, modifications to mesh size were also attempted. The Bermudian Government concluded that regulation the fish trap fishery was not effective and recently imposed a total ban on use of fish traps. The Council concluded that a total prohibition on the use of fish traps was the most effective alternative to address the stated problems and to achieve the plan's stated objectives.

SAFMC Prohibition on the use of fish traps
The Council prohibited the use of fish traps in the South Atlantic EEZ; however, black sea bass traps may be used north of Cape Canaveral (Vehicle Assembly Building, 28° 35.1' N Latitude).

6.2.2.3 Other Gear

Allowable Chemical

Collectors of live tropical reef fish commonly employ anesthetics such as quinaldine. Quinaldine (2-methy lquinoline, $C_{10}H_9N$) is the cheapest and most available of several substituted quinolines (Goldstein 1973). As a result of using this compound near corals where tropical species shelter, there may be residual effects which was discussed in a study by Japp and Wheaton (1975). Short-term impacts of quinaldine include increased flocculent mucus production, retraction of polyps and failure to re-expand 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 s mall 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.

Barrier Net

Barrier nets are used in conjunction with small tropical nets or slurp guns to collect tropical aquarium species. The net is deployed to surround a coral head or outcropping and may or may not have a pocket or bag that fish are "herded" into for capture. Barrier nets may be utilized by tropical fish collectors in both state and Federal waters.

The American Marine Life Dealers Association conducted a survey (Tullock and Resor 1996) that focused on tropical collection practices. The survey defined a sustainable fishing practice as one that a) does not cause physical damage to the reef environment; b) does not impair the captured specimen's longevity in a properly maintained aquarium environment; and c) does not damage non-target species such as coral polyps, other invertebrates, or non-aquarium fish. The survey concluded that barrier nets were a sustainable fishing practice. However, a study conducted by Öhman et al. (19 93) summarized that moxy nets, a type of barrier net that is used in other regions to collect ornamental fish species, may break corals during their use. How ever, it is likely that damage inflicted by barrier nets would be in frequent and incidental in nature, and there fore, t he gear would have a negligible effect on habitat.

Castnet

Used to capture baitfish and shrimp, castnets (Figure 18) are circular nets with a weighted skirt that is thrown over a schooling target. Castnets are primarily used in shallow areas such as estuaries, though they may be used to catch baitfish offshore in Federal waters. Castnets have the potential to dislodge organisms or become entangled if utilized over heavily encrusted substrates. Observations by the author have noted numerous castnets entangled amongst sponges and other growth around rough bottom. However, a study conducted by DeSylva (1954) determined that castnets have no detrimental effect on habitat.

Clam Kicking

Clam kicking is a mechanical form of clam harvest primarily practiced in the state waters of North Carolina. The practice involves the modification of boat engines in such a way as to direct the propeller wash downwards instead of backwards. The propeller wash is sufficiently powerful in shallow water to suspend bottom sediments and clams into a plume in the water column, which allows clams to be collected in a trawl net towed behind the boat (Peterson et al. 1987a).

Several studies have noted that the practice of clam kicking reduces algal and SAV biomass (Fonseca et al. 1984; Bargmann et al. 1985; Peterson et al. 1987a). Reduction of

SAV biomass was noted to increase with harvest intensity. Intense clam kicking treatments reduced S AV biomass by approximately 65% (Peterson et al. 198 7a). Because of the importance of SAV to coastal fisheries and estuarine productivity, Peterson et al. (1987a) noted that intense clam kicking could have long-lasting and serious impacts on many commercially important fisheries. However, clam harvesting had no detectable effect on the abundance of small benthic invertebrates and outside of SAV habitat, clam kicking does not appear to have any serious negative impacts on parameters of ecological value (Peterson et al. 1987a).

SAV recovery can be greater than two years if the rhizomes of the plant are removed (Homziak et al. 1982; Peterson et al. 19 87a). Peterson et al. (1987a) observed that SAV had yet to re cover after four years of an intense clam kicking treatment. Although Peterson et al. (1987a) designated their heavier clam kicking treatment as "intense," they conceded that it probably falls well short of the effort that commercial clammers would apply to a productive SAV bed. Limiting the intensity of clam fishing in SAV habitat would probably be beneficial. Peterson et al. (1987a) offered that a restriction of mechanical clam harvesters to unvegetated bottoms may be a suitable mechanism to minimize habitat damage.

Clam Rake, Scallop Rake, Sponge Rake and Oyster Tong

Rakes are used to harvest shellfish and sponges from shallow areas such as bays and estuaries. Oyster tongs, similar to two rakes fastened together and facing each other like scissors, are used by fishermen from the deck of a boat. As these gears are limited b y water depth, they are exclusively utilized in state waters.

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. Fished areas were also softer and had less odor of decomposition than the unfished control site. 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 5–7 m pole, which hooks the sponge s 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.

Peterson et al. (1987a) found that SAV biomass recovered to equal and even exceeded expected values with in one year. Lenihan and Micheli (2000) recommended the closure of some oyster reefs to shellfish harvest. Maintaining high densities of oysters on some intertidal reefs may help to preserve future oyster harvests and broodstock. Furthermore, protecting some reefs will also preserve the ecological functions that oyster reef provide such as improving water quality and providing essential recruitment, refuge, and foraging habitat for numerous marine species. Due to the extensive habitat that sponges provide, further ecological study on the directed harvest of these organisms should be conducted.

Dipnet and Bully Net

Widely utilized to catch baitfish, crabs, or lobster, varieties of dipnets (Figure 22) consist of a long pole with a bag of netting of varying mesh size that are lowered into the water. Dipnets may also be employed to capture tropical reef fish (Figure 23), though these utilize a short handle and very fine mesh. Additionally, landing nets or hand bully nets (Figure 24) used to capture lobster can be considered a form of dipnet. Varieties of dipnets may be used both in state and Federal waters.

DeSylva (1954) determined that dipnets have no detrimental effect on habitat. However, the use of small dipnets (i.e., tropical fish nets and lobster hand bully nets) may result in minor isolated impacts to coral species as individuals attempt to capture specimens (Barnette personal observation).

Hand Harvest

Hand harvest describes activities that capture numerous species such as lobster, scallops, stone crabs, conch, and other invertebrates by hand. As many small biogenic structures occur on the sediment surface, even gentle handling by divers can destroy them easily. Movements by divers were observed to cause demersal zooplankters to exhibit escape responses (Auster and Langton 1999). A study that assessed recreational SCUBA activity in the US Caribbean (Garcia-Moliner et al. 2000) concluded that approximately 2% of the total recreational divers in the USVI and 1.9% of the total recreational divers in Puerto Rico were lobstering. Potential impact of approximately 13,532 units occurred in the US VI and 14,946 units occurred in Puerto Rico. In this study, impact units consisted of two hands and two feet (4 units per diver) and impact was broadly defined as ranging from touching coral with hands to the resuspension of sediment by fins. No assessment of habitat degradation or long-term impacts was discussed. Divers pursuing lobster along coral or hard bottom communities have been observed to impact gorgonians and other en crusting organisms (Barnette unpublished observations).

Harpoon

Harpoons, thrown from the decks of a vessel, are utilized to target swordfish and tuna. As this gear is employed to harvest pelagic species, there is no contact with the benthos and, thus, no impact to habitat.

Haul Seine and Beach Seine

A haul seine is an active fishing system that t raps fish by encircling them with a long fence-like wall of webbing. It is made of strong netting hung from a float line on the surface and held near the bottom by a lead line. They are fished either along the shoreline (beach seine) where they are deployed in a semi-circle to trap fish between shore and net or, more typically, fish are encircled away from shore, worked into an even smaller pocket of net and lifted onto a boat for culling (Sadzinski et al. 1996). The use of this gear is limited to state waters. Sadzinski et al. (1996) found no detectable effects from haul seining on SAV. However, possible damage from haul seining to sexual reproduction, such as flower shearing, was not examined. There are possible long-term or cumulative impacts at established haul-out sites, resulting in loss of SAV biomass (Orth personal communication). As the seine is generally used in flat benthic areas to prevent the net becoming damaged, in most cases the impact from seines would be expected to be minor and temporary.

Hook and Line, Handline, Bandit Gear, Buoy Gear and Rod and Reel

These gear types 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.

Few studies have focused on physical habitat impacts 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. Due to the widespread use of weights over coral reef or hardbottom habitat and the concentration of effort over these habitat areas from recreational and commercial fishermen, the cumulative effect may lead to significant impacts resulting from the use of these gear types.

Patent Tong

Similar to hand tongs, hydraulic patent tong s (Figure 26) are much larger and are assisted with hydraulic lift, allowing them to purchase more benthic area in pursuit of oysters. Patent tongs are utilized in the oyster fisheries that occur in state waters. 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 $0.25m^3$.

Due to overfishing and disease, oysters may now be more economically valuable for the habitat they provide for other valued species than they are for the oyster fishery (Lenihan and Peterson 1998). Rothschild et al. (1994) suggested the establishment of broodstock sanctuaries that includes the designation of “no-fishing” restrictions in specific areas. Lenihan and Micheli (2000) also recommended the closure of some oyster reefs to harvest. Maintaining high densities of oysters on some intertidal reefs may help to preserve future oyster harvests and broodstock. Furthermore, protecting some reefs will also preserve the ecological functions that oyster reef provide such as improving water quality and providing essential recruitment, refuge, and foraging habitat for numerous marine species.

Purse Seine and Lampara Net

Purse seines 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. Purse seines in the Gulf menhaden fishery frequently interact with the bottom, resulting in sediment resuspension. Schoellhammer (1996) estimated that sediments resuspended by purse seining activities would last only a period of hours.

Pushnet

Employed to harvest shrimp in shallow water, pushnets (Figure 30) consist of netting supported by a frame that is mounted on to a pole, which is then pushed across the bottom. Pushnets are generally utilized on SAV beds where shrimp can be harvested in abundant numbers. DeSylva (19 54) determined that push nets have no detrimental effect on habitat.

Slurp Gun

A slurp gun is a self-contained, handheld device that captures tropical fish by rapidly drawing seawater containing such fish into a closed chamber. Slurp guns are typically employed on hardbottom and coral reef habitat in both state and Federal waters. It is possible that tropical collectors may impact coral or other benthic invertebrates in pursuit of tropical species that are harvested on hardbottom or coral habitat areas. However, due to the limited force applied by a diver in an errant fin kick or hand placement, the likely effects to habitat would be minor.

Snare

Recreational divers pursuing spiny lobster often use a long, thin pole that has a loop of coated wire on the end called a snare. The loop is placed around a lobster that may be residing in a tight overhang or other inaccessible location, and then tightened by a pull toggle at the base of the pole in order to capture and extract the lobster.

While there are no studies that evaluate this gear type, it is probable that use of this gear m ay minimize impacts to habitat in comparison to divers that use no additional gear (hand harvest). Due to the more surgical precision with the snare, divers likely impact the surrounding habitat to a lesser extent than if capturing by hand only due to the required leverage needed by the divers to capture a lobster by hand.

Spear and Powerhead

Divers use pneumatic or rubber band guns 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 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.

Gomez et al. (1987) concluded that spearfishing on reef habitat may result in some coral breakage, but damage is probably negligible. A study that assessed recreational SCUBA activity in the US Caribbean (Garcia-Moliner et al. 2000) concluded that approximately 0.7% of the total recreational divers in the USVI and 28% of the total recreational divers in Puerto Rico are spearfishing. Potential impact would be approximately 4,736 units in the USVI and 220,264 units in Puerto Rico. In this study, impact units consisted of two hands and two feet (4 units per diver) and impact was broadly defined as ranging from touching coral with hands to the resuspension of sediment by fins. No assessment of habitat degradation or long-term impacts was discussed. It may be assumed that divers pursuing pelagic species have no effect on habitat due to the absence of any interaction with the benthos.

6.3 Cumulative impacts of fishing and non-fishing activities

This section analyzes cumulative impacts, which are defined by the Council on Environmental Quality (CEQ) as “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.” Increasing evidence suggests that the most severe environmental effects may not result from the direct impacts of a particular action, but rather from cumulative environmental effects. The incremental loss of important habitat can irreversibly alter the structure and function of the nearshore marine ecosystem and ultimately affect human activities (Jackson 1997). Further, regional problems are highly vulnerable to small decision effects – the tyranny of small decisions, as evidenced in the Florida Everglades (Odum 1982).

The overall cumulative impact of human-induced activities and natural events remains poorly documented, understood, and in dire need of more study. Nationally, one report noted that “federal agencies have struggled with preparing cumulative effect analyses since the CEQ issued its National Environmental Policy Act (NEPA) regulations in 1978.” (CEQ 1997).

It is evident that the effect of human activity on aquatic systems has been substantial in locations where access and economically profitable modification could be readily accommodated. Dahl (1990) reports that in the 1780's there were about 20.3 million acres of wetlands in Florida, about 6.8 million acres in Georgia, about 6.4 million acres in South Carolina, and about million acres in North Carolina. By the 1980's Florida’s wetlands had been reduced to 11.0 million acres, Georgia’s to 5.3 million acres, South Carolina’s to 4.7 million acres, and North Carolina’s to 5.7 million acres. Overall about 36.3 percent of all wetlands in states under SAFMC purview have been eliminated. On a state-by-state basis this includes 46 percent of Florida’s wetlands, 23 percent of Georgia’s wetlands, 27 percent of South Carolina’s wetlands, and 49 percent of North Carolina’s wetlands. A 2001 National Research Council report found that, as a result, by the 1980s the area of wetlands in the contiguous United States had decreased to approximately 53 percent of its extent one hundred years earlier (NRC 2001).

According to the FWS Status and Trends of Wetlands in the Conterminous United States 1998 to 2004 there was an estimated net gain in wetlands of 191,750 acres, however the report did not draw conclusion regarding the quality of the nation’s wetlands and counted over 700,000 acres of open water ponds as wetlands. Intertidal wetlands declined by an estimated 28,416 acres, with the greatest percent change attributed to marine intertidal wetlands. The overriding factor in the decline of estuarine and marine wetlands was the loss of emergent saltmarsh to open saltwater systems due to and manmade activities such as dredging, water control, and commercial and recreational boat traffic. There was an estimated 800 acre gain of estuarine shrub wetlands, however most of this gain came from areas formerly classified as estuarine emergent wetland. Estuarine vegetated wetlands have continued to decline over time as losses to the estuarine emergent category have overshadowed the small gains to estuarine shrub wetlands (Dahl 2006).
As an indication of the scope of developmental pressure, hence one aspect cumulative effect on EFH (coastal and tributary wetlands), NMFS data show receipt of more than 20,778 individual development proposals (COE permit applications, federal projects, etc.) in North Carolina, South Carolina, Georgia, and Florida between 1981 and 1996 (See Tables 26, 27, 28, & 29). A subsample of 4,000 of these development proposals involved over 13,856 acres of various wetland habitats. Between 1996 and 2006, NMFS reviewed an additional 20,896 applications to impact areas known to support EFH (See tables ……..).

In addition to the substantial loss of wetlands in the southeastern United States, Nocholls et al (1999) determined that by the 2080s, sea-level rise could cause the loss of up to 22 percent of the world’s coastal wetlands. When combined with other losses due to direct human action, up to 70 percent of the world's coastal wetlands could be lost by the 2080s, although there is considerable uncertainty. Therefore, sea-level rise would reinforce other adverse trends of wetland loss.

While it is believed that most regulated activities are implemented as planned, Mager and Thayer (1986) report that limited monitoring indicate that about 20 percent of the projects they examined did not comply with provisions of the associated permits. Notably, most of the differences observed related more to design of structures and not the area of habitat affected. As shown in the following tables, individually and cumulatively significant impacts to EFH can be moderated through the COE regulatory program; however, significant wetland perturbations persist. This situation is largely perpetuated by (1) regulatory provisions that exempt regulation of certain wetland types and activities and (2) by severe staffing limitations within regulatory and environmental review agencies. In the absence of substantial correction in these two areas, significant wetland areas will continue to be adversely altered or eliminated, and regulatory and review agency effectiveness will be limited.

In addition to the direct cumulative effect incurred by developmental type activities, EFH is also jeopardized by persistent increases in certain chemical discharges. In that case incremental change in habitats, hydrology, and chemical inputs produced, over time, an enormous and extremely harmful result whose negative economic and social implications may far exceed any benefits related to the causative factors. Unfortunately, the effect of adding ever greater volumes and varieties of chemicals to surface waters is often insidious and resulting declines in the abundance and quality of affected and harvested resources may be slow and difficult to identify. As illustrated by Scott et al (1997), the effects may be realized at rudimentary trophic and ecological association levels in key portions (including EFH) of estuarine environments.

The rate and magnitude of anthropomorphic change on EFH, whether cumulative, synergistic, or individually large, is influenced by natural parameters such as temperature, wind, currents, rainfall, salinity, etc. Consequently, the level of threat posed by a particular activity or group of activities may vary considerably from location to location. This situation may be most acute in locations that are subject to extreme weather and oceanic conditions such as hurricanes and large waves, or where the effects of periodic or global change are most prevalent.

Nutrient over enrichment has become a large cumulative problem for southeastern EFH. Excessive nutrients may be directly toxic. Even relatively low nitrate-nitrogen levels (as low as 3.5 uM NO3-N) have been found to cause impacts on both growth and survival in eelgrass (*Z. marina*) during spring and fall growing seasons (Burkholder et al 1992). In contrast, Cuban shoal grass (*Halodule wrightii*) and widgeon grass (*Ruppia maritima*) were stimulated by nutrient enrichment (Burkholder et al 1994). Eelgrass provides important brackish water habitat element for finfish, crustaceans and molluscs in North Carolina (Thayer et al 1984). Nitrate toxicity to eelgrass in the field has yet to be documented, although nitrate concentrations in the range found to have an impact in mesocosm experiments certainly occurs in many estuarine settings.

The effects of nutrient enrichment and stimulation of toxic dinoflagellates and other algae, especially *Pfiesteria piscidida*, have been widely reported by the news media. The high abundance of small heterotrophic algae in southeastern estuaries was well known among plankton researchers during the 1980s and earlier; however, the toxic nature of *Pfiesteria* was not reported until the late 1980s (Burkholder et al 1992, 1993, 1995; Noga et al 1993). Analyses suggest that a large suite of *Pfiesteria*-like small heterotrophic dinoflagellates exist in most southeastern estuaries (P. Tester, personal communication). These organisms include toxic forms, like *Pfiesteria*, and may be responsible for a significant number of fish kills associated with eutrophic estuaries (Burkholder et al 1992). Fish kills in North Carolina and Maryland have been attributed, at least in part, to these organisms (Burkholder et al 1995), and analyses suggest that toxic dinoflagellates (and related organisms) are on the rise at a global scale (Paerl 1988, Smayda 1989, Paerl et al 1995a).

The stimulation of toxic organism population growth by nutrient enrichment may be related to factors outside the south Atlantic region. The most notable recent case was the transport of the toxic dinoflagellate *Ptychodiscus brevis* in 1989 by the Gulf Stream and associated eddies into Onslow Bay, North Carolina. Among other impacts offshore and inshore, this seriously impacted scallop production in Bogue Sound, North Carolina (Tester et al 1989).

Enrichment of estuarine algal and bacterioplanktonic communities by excessive nutrients is probably the most often cited example of estuarine degradation globally (Nixon 1995, NRC 1994, Ryther and Dunstan 1971). In general, the ecological pathway involves enhanced algal or bacterial production and metabolism followed by excessive oxygen uptake and subsequent deoxygenation. Anoxia and hypoxia have been identified as the fundamental problems facing Chesapeake Bay, the Gulf of Mexico, the Tar-Pamlico and Neuse River Estuaries, and other locations throughout the world (Paerl 1988).

Associated processes may be complex. For example, nutrient uptake and excessive autotroph production may result in deposition of organic material into benthic sediments, where increased sediment oxygen demand may occur at some later time. In stratified estuaries, the process may even be exacerbated by the re-release of nutrients as sediment oxygen demand is exerted in bottom, anoxic waters. The ecological effects of modification of production patterns also includes hypercapnia (elevated levels of carbon dioxide), which exerts powerful effects on some organisms (Burnett 1997).

Algal blooms in southeastern waters represent a major threat to EFH. Important algal blooms have been documented in Albemarle Sound, the Chowan River, the Tar-Pamlico River, the Neuse River Estuary, the New River Estuary, Bogue Sound, the St. Johns River and Indian River (NOAA 1996). Algal levels can be extremely high in grossly enriched waters. A one-day survey of the Pamlico Estuary in 1988 found chlorophyll a (an algal pigment) in excess of 200 ug/l, compared to a North Carolina Water Quality Standard of 40 ug/l (15A NCAC 2B.0200). Another type of algal community stimulation occurs when airborne nitrogen from all sources, including agriculture, is deposited through wet and dry deposition into distant oceanic waters. This phenomenon was largely unrecognized until recently (Paerl 1985, 1993). Consequences of this type of deposition, where the majority of “new” primary production comes from this source, can be quite significant, both on patterns in primary and secondary production and in the taxonomic makeup of that production, including the toxic forms cited above.

Among the most serious problems caused by algal blooms and other effects of over enrichment is the removal of oxygen from the water. The extent of deoxygenation in southeastern estuaries has been well documented (Rader et al 1987; Stanley, 1985). A more recent survey of the south Atlantic region found periodic hypoxic conditions in 13 of the 21 estuaries surveyed, with bottom-water anoxia in 11 locations. Only once instance of anoxia was found along the Sea Island Coast of South Carolina and Georgia, and this was linked to stratified conditions in the Savannah River. Major anoxic events were documented in the Neuse River, the Tar-Pamlico River Estuary, the Indian River and St. Helena Sound (NOAA 1996). Although seasonal low-oxygen events may be natural in Southeastern stratified estuaries, expansion in the size or persistence of deoxygenated areas has been identified for some of the above listed waters (Breitburg 1990, Rabalais et al 1996).

Effects of deoxygenation on resident and post-larval fish, crustacean, and mollusc communities can be significant. The enormous fish kills that have plagued the Tar-Pamlico and Neuse River Estuaries have received abundant popular press since the late 1980's, and have recently been systematically analyzed (Pietrafesa and Miller 1997). This study identified 246 kills in the Pamlico during the period 1985-1995, and 73 in the Neuse, including many over 1,000,000 fish. Fish kills have also been documented in the St. John River, Florida and Charleston Harbor, South Carolina (Burkholder et al 1995). Another possible manifestation of nutrient over enrichment is the occurrence of chitonoclastic shell disease in blue crabs. This is believed by some to be related to water pollution (either stress incurred after exposure to anoxic conditions or cadmium). Little is known absolutely (Noga et al 1990). In addition, fish diseases have been implicated throughout polluted estuaries, but the link to pollution remains uncertain (Noga et al 1989).

The impact of fish kills from nutrient over enrichment is difficult to assess in terms of their effect on stocks of commercially important fish. Many of the fish killed are juveniles and Atlantic menhaden appear especially vulnerable. If these stocks are density independent, then kills translate directly into reduced adult population sizes. Vaughan (1986) found that in Atlantic menhaden, catastrophic kills, where 10 percent mortality events occur periodically, coupled to the accumulating 1 percent annual losses from permanent habitat loss, could cause a loss of 60 percent of the fishery within 30 years. Impacts of atmospheric deposition of nutrients on inshore EFH is well documented, as cited above (and in Fisher and Oppenheimer, 1991). Some studies suggest that nutrient enrichment from atmospheric and more traditional surface water sources can also modify planktonic and epibenthic algal communities to the detriment of fish. Changes in the phytoplankton community lead to changes in the grazer community, including the reduction or elimination of preferred prey items for planktivorous fish and fish larvae. One example is the plankton community of Western Albemarle Sound, North Carolina, where nanoplankton (the small-celled algae that are the principal food source for crustacean zooplankters) are replaced in part in some years by blue-green algae of low food value, with a concomitant elimination of the zooplankters preferred by some anadromous fish larvae and juveniles (Rulifson et al 1986).

Besides fish, plankton, and algae, vascular marine plants also are adversely affected by excessive nutrients and their consequences. Eutrophication may cause the reduction in coverage of SAV due to shading associated with water column turbidity and the growth of epiphytic filamentous algae. Although significant die offs of SAV have occurred in some locations in the Southeast, including the Pamlico River Estuary, the direct causes of algal growth stimulation has not been established (Davis et al 1985). NOAA's 1996 survey of impacts on SAV found declines in 5 of 21 estuaries of the Southeast, including Albemarle/Pamlico Sounds, but increases in Biscayne Bay and Charleston Harbor (NOAA 1996).

A major problem with regard to assessing cumulative effects is that the majority of the methods developed to evaluate cumulative effects were developed in a terrestrial context and the applicability to marine resources and EFH is not clear. However, new analytical approaches may advance management evaluations of cumulative environmental effects. Ecological risk assessment procedures provide a useful frame for comprehensively structured analyses of anthropogenic effects (EPA, 1992). These procedures involve the systematic evaluation of stressors and effects using flexible methods that foster detailed evaluations of effects (Harwell et al., 1995). The application of risk assessment principles to environmental assessments could result in more comprehensive scientific products that also carry more administrative weight. In addition, systematic applications of decision support systems can offer logically consistent methods to evaluate multiple policy alternatives. Decision support systems aid the objective identification of appropriate decision combinations according to multiple priorities and they support group-based policy evaluations (Saaty, 1990; Keyes and Palmer, 1993; Schmoldt et al., 1994)). Combined utilization of these approaches may identify previously underemphasized factors and objective policy alternatives (Lindeman, 1997b). Ultimately, they may foster more logical and explicit decision-making regarding cumulative effects issues.

A cumulative assessment of population-scale fishing effects in the Florida Keys documents that 13 of 16 grouper species, 7 of 13 snappers, and 2 of 5 grunts are recruitment overfished (Ault et al., 1998). The cumulative result of technologically enhanced fishing effort has been the accelerated removal of those top predators with most economic value. Therefore, intensive effort is now being expended to obtain species that are lower on the food chain (Pauley et al., 1998). This has serious implications; as the lower levels of the food chain decline, the chances of revival at the top of the food chain are diminished even further (Williams, 1998). Top-down ecosystem degradation can result in a variety of unfavorable species abundance shifts (Goeden, 1982) and, potentially, outright ecosystem collapse (Pauley et al, 1998). Further cumulative assessments of managed species in the South Atlantic may reveal long-term declines similar to those now identified in the Keys. Under such circumstances, traditional management measures (e.g., size and harvest limits), may not be adequate to rebuild sustainable fisheries for the most desirable species.

7.0 Essential Fish Habitat Evaluation and Recommendations

7.1 Conservation and restoration

7.1.1 Riverine System

7.1.2 Freshwater Wetlands

7.1.3 Submersed Aquatic Vegetation

7.1.4 Estuarine Marshes

Efforts to restore or create salt marsh habitat have been underway for over 20 years, as losses of coastal wetlands through erosion, land subsidence, sea level rise and coastal development have increased (Nixon 1980; Matthews and Minello 1994). Salt marsh restoration has received much attention in recent years. This is likely due to the considerable acreage of salt marsh that has been lost along U.S. coastlines, recent recognition of the important functions provided by salt marshes, and the relative ease in which tidal marsh vegetation can be propagated at restored sites. Restoration or creation of marsh habitat begins with designing a site with the appropriate hydrology, tidal exchange, and sediment properties to support the growth of salt marsh plants. Analyses of current and projected land-use patterns, and socioeconomic factors are necessary and may be a critical factor in the final selection of possible restoration sites. Salt marsh restoration projects that lack clearly defined goals and objectives are less likely to achieve success.

Often, restoration of tidal flushing, combined with the existence or creation of an appropriate marsh morphology (i.e., elevation, slope, grade, substrate, etc.) will be enough to rapidly revegetate the area with native salt marsh communities (see Sinicrope et al., 1990). However, if the site is isolated from sources of recolonizing vegetation, planting may be required in order to decrease the length of time before natural revegetation occurs. Planting, though potentially costly, is beneficial in the restoration of sites damaged by pollution, e.g., an oil spill (Matsil & Feller, 1996), and can hasten re-establishment of target salt marsh vegetative communities.

Subsequent to physical modification of the site, plantings are often made of *Spartina alterniflora* or, less frequently, of other marsh plants. Planting growing or dormant plants, or plant propagules, is the most reliable planting method for salt marsh restoration projects (Broome et al., 1988; Garbisch et al., 1975). Given appropriate site selection and preparation, successful establishment of *Spartina* and/or other marsh species can occur within a few growing seasons.

An important, and still unanswered, question relative to marsh habitat restoration is how long it takes to restore marsh habitat function, as opposed to simply the replacement of marsh plants; this evaluation of habitat function is complex and time-consuming. Examples of marsh functions to be evaluated are food web support, provision of fishery nursery grounds, and the transformation of nutrients (Smith et al. 1995). Research on monitoring methods often is focused on determining the functions provided by a restored habitat and comparing the functions to those provided by natural systems. Evidence to date suggests that the time it takes a transplanted salt marsh to attain the ecological function of a mature natural marsh may be 10 to 20 years. If the hydrology and tidal elevation of the site are not maintained, then the transplanted marsh may never supply equivalent habitat function as a natural marsh. This is particularly important to recognize in cases where marsh restoration or creation is undertaken to mitigate for the loss of natural marsh via development, dredging, or other permitted activities. Most studies indicate that overall restored salt marshes are providing fish access to usable habitat and the systems are functioning to increase growth, production, and resilience of fish populations. However, in some cases restored systems may be structurally or functionally different from natural marshes. Continued research will help determine whether improved restoration methods could improve functional equivalency.

7.1.5 Mangroves

Threats

While much of the mangrove forest area is protected in the U.S. under the jurisdictions of parks, sanctuaries and refuges (Gilmore and Snedaker 1993, Thayer et al. 1999), this coastal habitat and resource is being progressively diminished by a variety of natural and anthropogenic actions such as removal, severe pruning, deprivation of freshwater from upland watersheds, severe freezes, water pollution, competitive exclusion by exotic tree species (e.g., Australian pine, Brazilian pepper), coastal erosion and sea-level rise. Most of these aspects have been discussed and/or documented by Odum et al. (1982) and Gilmore and Snedaker (1993), and are discussed under the section Essential Fish Habitat.

Removal and alteration to freshwater flow are the top threats to mangrove forests in Florida. Although both federal wetland regulations and local ordinances are in place to protect mangroves, legislation has not proved very effective. A burgeoning human population has increased the realized and potential negative impacts of human activities on coastal habitats in regions with limited land mass and a fragile ecology. As of 1991, development in the Florida Keys had destroyed roughly 40 % of mangrove forests and reduced mean forest size by 69% (Strong and Bancroft 1994). Further north towards Miami, the acreage of mangrove forest in Biscayne Bay’s watershed has declined by as much as 82% since the 1970’s (Teas et al. 1976; Snedaker and Biber 1996).

Substantial area of mangrove habitat has been lost by impoundment. Impoundment involves the creation of a dike and ditch system around the perimeter of the wetland so that water levels in the wetland can be artificially raised to prevent ovideposition on the substrate by marsh mosquitoes. From the mid-1950s to today, over 16,000 hectares of mangrove forests and salt marshes along the Indian River Lagoon System (Florida) have been impounded, making this method the most common technique used to prevent new generations of mosquitoes in Florida (Rey & Kain 1990; Rey et al. 1991). Permanent impoundment and high water levels prevented the effective gas exchange through mangroves root systems and resulted in chronic mortality similar to that an oil spill might cause. Permanent impoundment also severed the connection between resident mangroves and the surrounding ecosystem (i.e., effective removal). Today, a rotational impoundment system (RIM) is used, and culverts fitted with flapgates can be seasonally opened and closed (Carlson et al. 1991). RIM is a much more ecologically benign system of mosquito control and coastal marsh management because it allows for the seasonal exchange of water, nutrients, and aquatic fauna.

Mangroves are considered resilient and display characteristics of some "pioneer species" in that they have broad tolerances to environmental factors, rapid growth and maturity, continuous or almost continuous flowering and propagule production, high propagule outputs in a wide range of environmental conditions, and adaptations for short and long distance dispersal by tides (Cintron-Molero 1992). Even with these "r-strategist", characteristics, mangroves are sensitive and vulnerable to disturbance. Changes to the freshwater flow from the Everglades to coastal mangrove forests since the late 1800s have coincided with ecological declines in the region (Light and Dineen 1994; Sklar et al. 2001). Marine intrusion into traditionally freshwater areas has resulted in a several-kilometer expansion of the coverage of mangrove forests in the region (Ross et al. 2000). The replacement of a narrow fringe and riverine forest (comparatively high production forests) with an expansive dwarf forest (a comparatively low production forest) complicates assessment of the change over time in the total productivity of the region's mangroves.

7.1.6 Seagrass

Threats

Like all other organisms and habitats in estuarine-near shore environments, seagrasses occur at the end of all watershed inputs: the juncture between riverine inflow and oceanic inputs as well as the interface between land and sea. This situation makes them extremely susceptible to perturbations by natural processes as well as being susceptible to damage by human activities (Short and Wyllie Echeverria, 1996).

In the South Atlantic region seagrasses experience natural disturbances such as bioturbation (stingray foraging), storm or wave-related scour (tropical storms and surges), and disease or disease-associated perturbations (*Labyrinthula*), as well as man-related impacts (Short and Wyllie-Echeverria 1996). Especially problematic are excessive epiphytic loads and smothering by transient macroalgae, both of which are often associated with nutrient enrichment and coastal eutrophication. Excessive nutrient discharges and suspended sediments can also disrupt seagrass systems by causing water column algal blooms that diminish the amount of light available for benthic dwelling seagrasses (Dennison et al. 1993). Often, nutrient enrichment will have detrimental effects that cascade up and down the food webs of seagrass meadows by diminishing the dissolved oxygen concentrations and stressing the faunal communities. Also toxic concentrations of hydrogen sulfide may be formed which kills seagrass and diminish the ability of a meadow to filter and stabilize sediments, thus altering the water column environment for filter feeders and other primary producers.

Subtidal seagrasses have suffered little damage from oil spills whereas impacts on intertidal beds have been significant (Durako et al. 1993, Kenworthy et al. 1993). Oil spill-related impacts on the seagrass-associated fauna can range from smothering to lowered stress tolerance, reduced market values and incorporation of carcinogenic and mutagenic substances into the food chain. Other well-known impacts such as newly permitted dredge and fill operations are no longer a primary cause of major losses of seagrass habitat due to the recognition of their ecological role and vigilance of state and federal regulatory activities to limit permits. Dredging activities which are grandfathered into water management plans are potential problems causing turbidity, resuspension of toxic compounds and direct removal of seagrass. This human-related impact, although still present, is now being replaced by a larger issue, that associated with propeller scouring (Sargent et al. 1995), vessel groundings (Kenworthy et al. 2002), and some fishing gear-related impacts (Fonseca et al. 1984). This physical damage is long-lasting and often results in sediment destabilization and continued habitat loss (Kenworthy et al. 2002; Whitfield et al. 2002). The increasing number of small boats plying estuarine and coastal waters has made vessel impacts more widespread, and there has been a recognized need in some regions for both enhanced management of these systems and increased awareness by the boating public.

Water quality and, in particular, water clarity is now considered among the most critical, if not the most critical, factor in the maintenance of healthy SAV habitats (Dennison et al. 1993). In the past few years it has become increasingly evident that, with few exceptions, seagrasses generally require light intensities reaching the leaves of 15-25% of the surface incident light (Kenworthy and Fonseca 1996, Gallegos and Kenworthy 1996, Onuf 1996; Dixon 1999; Gallegos 2001). However, water transparency standards historically have been based on light requirements of phytoplankton which typically require only 1% of surface light (Kenworthy and Haunert 1991). Many factors act to reduce water column transparency, with excess suspended solids and nutrients being considered to be among the most important and most controllable through watershed management practices (Gallegos 1991).

The loss of seagrasses, regardless of the cause, leads to several undesirable, and often difficult to reverse, situations that reflect on aquatic vascular plant ecological values (Moore, 2004). Losses can and have led to reduced sediment binding and water motion baffling capability of the habitat allowing sediments to be more readily resuspended and moved ((Fonseca 1996), eventually disturbing other components of coastal ecosystems such as coral reefs. The physical ramifications include reef degradation, increased shoreline erosion (e.g., as occurred in some areas after the eelgrass die-off in the 1930's) and water column turbidity. The loss of seagrasses, of course, eliminates all important associated habitat functions pertinent to fisheries use.

Aspects of Conservation and Restoration

The recognition of the ecological role of seagrass habitats has prompted a need to conserve, and more recently protect these habitats by avoiding impacts (i.e., proactive management) (Fonseca et al. 1998; Kenworthy et al. 2005). This is a less costly and an environmentally sounder means of protecting this important resource than either mitigation or restoration. None-the-less, seagrass habitats have been and continue to be impacted or lost, and restoration efforts have broadened to include development and evaluation of new approaches to seagrass restoration and measurements of recovery of functional values (Fonseca et al 1998; Fonseca et al. 2000). In addition, programs are being developed to plant seagrasses for purposes of sediment stabilization, nutrient uptake, and fishery habitat (Kirsch et al 2004). These programs and projects, which consult with experts, utilize scientifically based guidelines, and monitor their restoration success. Research continues to evaluate current techniques and develop new approaches. However, we have not found a restoration or mitigation project that has returned seagrass habitat equal to that which has been lost. Much has been written on techniques and evaluation of restoration tools for seagrasses along the South Atlantic coast of the U.S. (Fonseca et al. 1998). Data are showing that if seagrass transplanting is successful we can expect a similar faunal community to return within a few years (2-4 possibly), depending on the geographic area and rate of development of the transplant (Fonseca et al. 1996). There are many uncertainties associated with seagrass mitigation and restoration such as impacts of herbivory, but experience is showing that efforts can be successful if the well-founded guidelines available are followed.

7.1.7 Oyster reefs and shell banks

Shell bottom restoration in North Carolina
(Source: NCCHPP)
State efforts to restore oyster habitat and enhance oyster fishery production began around the turn of the century (Marshall et al. 1999). These efforts relied mostly on planting a variety of natural cultch, including oyster, clam, and scallop shells, and, more recently, limestone marl. Experimental oyster cultch plantings began in 1900, and state-sponsored cultch planting began in 1915 (Marshall et al. 1999). Between 1915 and 1934, a total of 1,856,379 bushels of shells and seed oysters were planted in North Carolina's estuaries. The Oyster Rehabilitation Program officially began in 1947 and resulted in planting 838,088 bushels of shell and 350,734 bushels of seed oysters over its first 10 years. Since 1970, North Carolina has relied almost exclusively on cultch planting as a means of enhancing oyster production (Figure 3.5). From 1958 to 1994, 12,475,000 bushels of shell material were planted, for an annual average of 337,162 bushels (Marshall et al. 1999). Over the entire period of cultch planting from 1915-1994, about 15 million bushels of oysters were planted in North Carolina waters. This volume of shells would contain the equivalent of 4.5 billion 2-inch oyster shells. Using a minimum 30% area coverage (100 2-inch shells/m2) as defining shell bottom, the volume of shell cultch planted from 1915-1994 could cover as much as 11,120 acres (45,000,000 m2). However, this is an overestimate of actual shell bottom area gained, because the shell plantings consist of piles of variable thickness rather than a single uniform layer. Also, many of the cultch areas are replanted due to flattening by waves and/or commercial harvesting.

Despite these planting efforts, the oyster harvest continued to decline (Marshall et al. 1999).

Figure 3.5. North Carolina oyster rehabilitation activities for 1947 – 1994 (data stacked to show cumulative total). The peak in 1988 was due to special state disaster funding during the red tide of 1987-88. (Source: Marshall et al. 1999)

Similar to natural shell bottom, restored oyster reefs provide bottom habitat for economically important species (Breitburg 1998; Lenihan et al. 1998; Coen et al. 1999; Harding and Mann 1999; Grabowski et al. 2000; Lenihan et al. 2001; Peterson et al. 2003a). Recent studies have examined the habitat value of constructed oyster reefs compared to natural oyster reefs. The researchers found that landscape characteristics seemed to influence fish species' relative abundance (i.e., connectivity with SAV and/or salt marsh). Fish abundance was significantly greater on restored oyster reefs adjacent to SAV than on mud flat and/or salt marsh restored reefs (Grabowski et al. 2000). Restored intertidal oyster reefs produced significantly more economically valuable oysters ($95.68/10 m2) than estimates of oyster production on subtidal reefs ($11.61/10 m2). The value of legal oysters present on mud flat reefs ($129.38/10 m2) exceeded that for oysters on salt marsh ($50.50/10 m2) or SAV restored reefs ($24.25/10 m2). They estimated that the long-term value of commercial fisheries landings from restored reefs was greater than the oyster harvest for both intertidal and subtidal shell bottoms.

The habitat benefits of cultch plantings may only be limited or temporary if the shell bottom is removed or damaged by towed fishing gears or other harvesting gears (Marshall et al. 1999). Cultch plantings in the southern areas (Onslow, Pender and New Hanover counties) are frequently replanted after harvesting to replenish cultch material for recruitment (Marshall et al. 1999). It generally takes about 3-4 years before oysters on planted sites reach harvestable size in the Pamlico Sound system, while oysters reach the minimum legal size of 3 inches in about two years in the southern coastal area. Faster growth in this area is due to higher rates of water exchange caused by greater tidal flow than in most of Pamlico Sound. The increased flow brings in more food and prevents oxygen depletion problems.

The majority of cultch planting sites during 1990-1994 were in Pamlico Sound, lower Neuse River and lower Pamlico River (Marshall et al. 1999). The same general areas were also planted in 2001 and 2002 (Maps 3.4a-b). Most of the recent (2001-2002) oyster restoration effort has been conducted in large bays around Pamlico Sound and in smaller tributaries of other estuaries (Maps 3.4a-b). The majority of these sites are "new" plantings on basically barren sediment (Marshall et al. 1999). Criteria for site selection include suitable sediment types, currents, protection from storm damage, historical productivity, salinity patterns, and existing shellfish concentrations. The presence of bottom disturbing fisheries, such as trawling, hydraulic clamming, and long haul seining, is also considered. Recommended sites for cultch plantings are often narrow bands of mixed sand and mud sediment between shallow, hard, nearshore sediment and soft offshore sediment. In deep water, large oyster mounds are constructed to increase recruitment and reduce effects of low oxygen on the bottom. The planting sites are monitored for oyster recruitment and survival over a period of three years (DMF 2001a). Using vessels currently in operation, cultch can be planted in water as shallow as two feet (Marshall et al. 1999). Since the early 1980s, the DMF has concentrated primarily on cultch plantings and small-scale, high quality seed transplanting activities, also referred to as the "relay program." In the relay program, oysters are removed from dense oyster populations in prohibited areas and relocated to open harvest areas with depleted resources. The relay program is very small and concentrated in the south, where there is very little effect on the seed source areas (M. Street, DMF, pers. com., 2003).

The primary purpose of the DMF cultch-planting program since it began has been oyster fishery enhancement. The DMF enhancement efforts have also been directed at providing stable long-term oyster habitat because research in recent years shows that oyster reefs have important ecological and economic value as coastal fisheries habitat. This broadening of focus for the protection/restoration program has occurred since the late 1990s. As of 2001, there were five constructed/artificial reef sanctuaries in North Carolina located in Bogue Sound, West Bay (Tump Island), Deep Cove (Swan Quarter), Croatan Sound, and behind Hatteras Village (DMF 2001a). Work is currently underway to enhance several existing restoration sites and create additional sites. These areas are no-take, no-disturbance sanctuaries (C. Hardy, DMF, pers. com., 2002). In other states, sanctuaries are a major component of restoration efforts (CBP 2000). Creation of additional "no take" subtidal oyster sanctuaries has been recommended by Frankenberg (1995), the Chesapeake Research Consortium (1999), and Lenihan et al. (1998). There are multiple ecological benefits of constructed and natural oyster sanctuaries, including the following (Breitburg et al. 2000):

- Protection of brood stock,
- Enhancement of oyster populations in surrounding harvested areas through larval dispersion,
- Protection of disease-resistant oysters, improving the genetic pool for disease resistance, and
- Protection of associated fisheries and other organisms from predation through development and maintenance of maximum vertical relief and structural complexity.

The first true oyster reef restoration project in North Carolina occurred in 1992-1993 when 13 acres of oyster producing habitat were created as mitigation for the loss of 16 acres of estuarine bottoms and 1.5 acres of wetlands in Roanoke Sound (Marshall et al. 1999). The DMF is monitoring the site as part of a mitigation agreement with the U.S. Army Corps of Engineers (COE). More recently, the DMF has performed mitigation projects for the North Carolina Department of Transportation, and additional projects creating more than 70 acres of shell bottom are planned with the COE (Marshall et al. 1999). Research is continuing on how to better construct these sites to provide effective oyster habitat. However, in the Pamlico Sound region where spatfall continues to decline (Marshall et al. 1999), more planting and longer protection of sites may be required to achieve the same results as previous restoration efforts. Restoration efforts must use knowledge of larval availability in order to be most effective. In southern waters, the amount of shell habitat is generally stable, but the amount of harvestable area is decreasing as closures increase because of contamination from storm water runoff (R. Carpenter, DMF, pers. com., 2002).

Restoration of shell bottom is also undertaken by non-profit groups. One such project has been initiated in Pamlico Sound by The Nature Conservancy, in cooperation with NOAA's Community-Based Restoration Program and several partners. The goal of the Project is to enhance the biological diversity of Pamlico Sound by establishing a self-sustaining complex of living oyster reefs throughout the estuary. The Conservancy has enlisted the cooperation of marine scientists to ensure the most up-to-date techniques for siting, construction and management are used. Some criteria for site selection include depth, salinity, shellfishing-prohibited status, disease-resistant salinities, reef footprints, presence of larvae, and proximity to SAV, salt marsh, fish nursery areas, or Military Protected Areas. States and territories containing anadromous, estuarine, and marine species are eligible to compete for Community-Based Restoration grants typically ranging from $25,000 to $75,000.34 As the number of oyster restoration projects grows, the need for an overall strategy for shell bottom restoration also increases.

Any expansions of the current restoration/enhancement effort will require additional sources and funding for oyster cultch or limestone marl. Funding for the acquisition of cultch material was drastically cut in DMF's 1990 budget. As a result, the DMF currently has more planting capability than available cultch material. Funding for acquisition of cultch material must be increased to more efficiently use the existing planting capabilities of DMF. The DMF began a voluntary shell-recycling program in 2004 using local coordinators to collect discarded shells from individuals and businesses. The shells are later transferred to stockpile facilities before being planted in new or expanding oyster sanctuaries. The amount of cultch volunteered could somewhat offset the amount of funding needed for additional cultch material. However, the amount of cultch volunteered is probably secondary to the public awareness gained from a shell-recycling program.

Shell Bottom Restoration in South Carolina

Note: The following text is excerpted from the SCDNR website and from Walker (2005).
Human activities, in concert with natural phenomena, have greatly affected the distribution and abundance of oysters in the United States. In many areas, oyster habitats have declined precipitously in recent years due to numerous causes, including over-harvesting, destruction of habitat, water pollution, and other effects related to coastal development.

South Carolina's shellfish resources, particularly its subtidal oyster beds, have diminished over the years due to salinity regime changes resulting from a variety of factors including Atlantic Intracoastal Waterway construction; Santee/Cooper River diversion and rediversion; and, accelerated freshwater inflow into estuaries caused by wetland drainage projects and the clearing of land for forestry and agricultural purposes (Walker 2005). While the intertidal oysters of South Carolina may still appear to be abundant there is increasing evidence of negative effects from anthropogenic (man-made) stressors such as nonpoint source runoff, construction of docks and marinas, improper harvesting techniques, and wakes from recreational boat traffic. In fact, in many of the more heavily utilized creek systems, essentially no oysters remain.

South Carolina oyster resources also suffer from a lack of husbandry (conservation), particularly in the common property grounds managed by the state. Appropriate husbandry includes replanting of oyster shell to provide substrate for subsequent generations. If removal of oysters by harvesting is not offset by replanting, the resource declines due to insufficient substrate. A shortage of shell for replanting and a lack of funds for staff and equipment have severely limited the scope of shell replanting by the state of South Carolina (Walker, 2005).

<u>Oyster Restoration Activities in South Carolina</u>

Oysters will readily recruit to planted shell substrate in areas that otherwise have little or no recruitment due to lack of suitable attachment sites. In South Carolina there are adequate breeding populations (adult stocks) but recruitment is limited by substrate. Although a fully functional reef requires at least 3 to 5 years to develop, a remarkable suite of invertebrates (over 85 species) quickly colonizes the oyster reefs, providing food sources for larger invertebrates and finfish and beginning the natural process of stabilizing the reef.

Planting of shell can also help to trap sediments and absorb wave energy, reducing erosion of adjacent salt marshes. With careful site selection, replanting of shell can restore oyster habitat by providing substrate for juvenile oysters, which grow to form a self-sustaining reef.

Oyster restoration and enhancement efforts in South Carolina are conducted by the South Carolina Department of Natural Resources (SCDNR) and include large-scale replanting in public shellfish grounds supported by saltwater license revenues, small-scale community-based restoration through the SC Oyster Restoration and Enhancement (SCORE) program, and the shell recycling program. The latter two programs are described in greater detail below.

SCORE - South Carolina Oyster Restoration and Enhancement Program

The South Carolina Department of Natural Resources (SCDNR) is responsible for managing the state's oyster resources. Appropriate management includes the planting of material to provide substrate, known as cultch, for recruitment of juvenile oysters. The best cultch material is oyster shell.

In order to increase oyster habitat at the minimum cost to taxpayers, SCDNR has initiated the South Carolina Oyster Restoration and Enhancement (SCORE) program. There are two major components to the SCORE program: oyster shell recycling and community-based restoration. By working together, community members and biologists can restore oyster populations while 1) enhancing habitat for fish, shrimp, and crabs, 2) improving water quality of estuarine areas, and 3) informing and educating children, industry, and the general public.

Oyster Shell Recycling
Immature oysters at the free-swimming larvae stage require a solid surface or substrate for attachment, which is called "setting." Once attached, oysters cannot relocate. Not surprisingly, oysters have evolved a preference for setting on other oyster shell. Adult oysters and even shells of dead oysters emit chemicals that attract oyster larvae. By selecting oyster shells as a substrate, the larvae maximize the likelihood of setting near other oysters (a requirement for reproduction) and of setting in a suitable habitat.

Unfortunately, there is a nationwide shortage of oyster shell to be used as cultch. That which is available is often not readily accessible because it is spread out in many locations. SCDNR has initiated an effort to encourage the public to recycle oyster shell for use in resource management. Recycling centers have been established at several sites along the coast.

Consumers are encouraged to deposit clean shell (i.e., no trash) in designated bins at the recycling centers, which are periodically emptied by SCDNR. The shell collected in this manner is then used for restoration and enhancement of shellfish resources, thus reducing the cost of these activities. Community groups and youth organizations may wish to recycle shell as a community service project. An abundance of oyster shell ends up being discarded by restaurants, caterers, resorts, and from private oysters roasts, so it is important to recapture it before it is sent to the landfill.

Community-Based Restoration
The restoration component of the SCORE program depends on local citizen groups working closely with SCDNR staff to construct oyster reef habitat, and to monitor the success of those efforts. Since May 2001, more than 2000 volunteers have used more than 250 tons of recycled shell to construct approximately 2,369 m2 of oyster reef habitat at 30 sites along the South Carolina coast, from Murrells Inlet to Pinckney Island. After the reefs are constructed, volunteers are trained to monitor water quality, reef development, and reef/shoreline interactions. The overall goal of the SCORE program is to protect oyster reef habitats by increasing citizen awareness of the ecological importance of these habitats and the potential negative effects of human activities on these fragile ecosystems. By involving citizens in the restoration process the SCDNR hopes to accomplish the following:

- Develop a citizen constituency for oysters
- Initiate a grass-roots effort to restore oysters
- Increase public awareness of the value of oysters to the ecosystem
- Influence public policy to provide greater protection for oyster habitats
- Influence lawmakers to provide adequate funding for proper management of oyster resources
- Expand the scope of our endeavors by utilizing volunteer labor.

Recommendations for shellfish management
Intertidal oyster reefs serve to buffer shorelines from coastal erosion, improve water quality, and provide habitat for other species. Oysters are also highly prized for human consumption, and should be managed sustainably to allow for continued harvesting, as

well as to provide ecological services. Walker (2005) lists recommendations for shellfish management changes in South Carolina, which are based on comparisons with other states and interviews with agency staff and other stakeholders within South Carolina. These recommendations include considering the importance of shellfish resources beyond their consumptive value when making management decisions, increasing the number of inter and intra-agency planning meetings to streamline management, increasing replanting funds and efforts, reviewing Culture Permit and State Shell Shellfish Ground management, and continuing information exchange with the industry.

7.2 Description and use of current and proposed EFH, EFH-HAPCs and Coral HAPCs

7.2.1 Penaeid and deepwater shrimp

7.2.1.1 Essential Fish Habitat

Penaeid Shrimp
For penaeid shrimp, Essential Fish Habitat includes inshore estuarine nursery areas, offshore marine habitats used for spawning and growth to maturity, and all interconnecting water bodies as described in the SAFMC Habitat Plan (SAFMC 1998a). Inshore nursery areas include tidal freshwater (palustrine), estuarine, and marine emergent wetlands (e.g., intertidal marshes); tidal palustrine forested areas; mangroves; tidal freshwater, estuarine, and marine submerged aquatic vegetation (e.g., seagrass); and subtidal and intertidal non-vegetated flats. This applies from North Carolina through the Florida Keys.

Rock Shrimp
For rock shrimp, essential fish habitat consists of offshore terrigenous and biogenic sand bottom habitats from 18 to 182 meters in depth with highest concentrations occurring between 34 and 55 meters. This applies for all areas from North Carolina through the Florida Keys. Essential fish habitat includes the shelf current systems near Cape Canaveral, Florida which provide major transport mechanisms affecting planktonic larval rock shrimp. These currents keep larvae on the Florida Shelf and may transport them inshore in spring. In addition the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse rock shrimp larvae.

The bottom habitat on which rock shrimp thrive is thought to be limited. Kennedy et al. (1977) determined that the deepwater limit of rock shrimp was most likely due to the decrease of suitable bottom habitat rather than to other physical parameters including salinity and temperature. Cobb et al. (1973) found the inshore distribution of rock shrimp to be associated with terrigenous and biogenic sand substrates and only sporadically on mud. Rock shrimp also utilize hard bottom and coral or more specifically Oculina coral habitat areas. This was confirmed with research trawls capturing large amounts of rock shrimp in and around the Oculina Bank HAPC prior to its designation.

Other than Kennedy et al. (1977), no characterization of habitat essential to rock shrimp has been conducted. A list of species associated with the benthic habitat inhabited by rock shrimp was compiled from research trawling efforts (1955-1991) that captured harvestable levels of rock shrimp. In addition, Kennedy et al. (1977), during research efforts sampling the major distribution area of rock shrimp off the east coast of Florida, compiled a list of crustacean and molluscan taxa associated with rock shrimp benthic habitat.

Royal Red Shrimp

Essential fish habitat for royal red shrimp include the upper regions of the continental slope from 180 meters (590 feet) to about 730 meters (2,395 feet), with concentrations found at depths of between 250 meters (820 feet) and 475 meters (1,558 feet) over blue/black mud, sand, muddy sand, or white calcareous mud. In addition the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse royal red shrimp larvae.

7.2.1.2 Essential Fish Habitat-Habitat Areas of Particular Concern

Penaeid Shrimp

Areas which meet the criteria for essential fish habitat-habitat areas of particular concern (EFH-HAPCs) for penaeid shrimp include all coastal inlets, all state-designated nursery habitats of particular importance to shrimp (for example, in North Carolina this would include all Primary Nursery Areas and all Secondary Nursery Areas), and state-identified overwintering areas.

Estuarine tidal creeks and salt marshes that serve as nursery grounds are perhaps the most important habitats occupied by penaeid shrimp. The major factor controlling shrimp growth and production is the availability of nursery habitat. Remaining wetland habitat must be protected if present production levels are to be maintained. In addition, impacted habitats must be restored if future production is to be increased. Other areas of specific concern are the barrier islands since these land masses are vital to the maintenance of estuarine conditions needed by shrimp during their juvenile stage. Passes between barrier islands into estuaries also are important since the slow mixing of sea water and fresh water are also of prime importance to estuarine productivity.

In North Carolina, essential fish habitat-habitat areas of particular concern include estuarine shoreline habitats since juveniles congregate here. Seagrass beds, prevalent in the sounds and bays of North Carolina and Florida, are particularly critical areas. Core Sound and eastern Pamlico Sound, based on a preliminary aerial survey funded through the Albemarle-Pamlico Estuarine Study, have approximately 200,000 acres of seagrass beds making North Carolina second only to Florida in abundance of this type of habitat (Department of Commerce 1988b). In subtropical and tropical regions shrimp and spiny lobster postlarvae recruit into grass beds from distant offshore spawning grounds (Fonseca et al. 1992).

South Carolina and Georgia lack seagrass beds. Here, the nursery habitat of shrimp is the high marsh areas with shell hash and mud bottoms. In addition, there is seasonal movement out of the marsh into deep holes and creek channels adjoining the marsh system during winter. Therefore, the area of particular concern for early growth and development encompasses the entire estuarine system from the lower salinity portions of the river systems through the inlet mouths.

Section 600.815 (a) (8) of the final rule on essential fish habitat determinations recognizes that subunits of EFH may be of particular concern. Such areas, termed Essential Fish Habitat- Habitat Areas of Particular Concern (EFH-HAPCs), can be identified using Identification of habitat areas of particular concern. FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern based on one or more of the following considerations: (i) The importance of the ecological function provided by the habitat; (ii) The extent to which the habitat is sensitive to human-induced environmental degradation; (iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type; and (iv) The rarity of the habitat type. The following is a summary evaluation of the EFH-HAPC as it relates to the criteria:

Table 7.2-1. EFH-HAPC and Criteria Evaluation, Penaeid Shrimp

EFH-HAPC and Criteria Evaluation	Ecological Function	Sensitivity to Environmental Degradation	Threat from Development Activities	Rarity of Habitat
Coastal inlets	High	Low	Medium	Medium
State-designated nursery habitats	High	High	Medium	High
State-identified overwintering habitats	Medium	Low	Medium	Medium
Barrier islands				
Passes between barrier islands and inlets	Medium	Low	Medium	Medium
Estuarine shoreline habitats in NC	High	Medium	Low	Medium
Seagrass beds in NC and FL	High	High	Medium	High
High marsh areas with shell hash and mud bottom in SC and GA	High	Medium	Medium	Medium
Estuarine systems from low salinity portions of rivers to inlet mouths	Medium	High	High	Medium

Rock Shrimp
No essential fish habitat areas of particular concern have been identified for rock shrimp; however, deep water habitat (e.g. the rock shrimp closed area/proposed expanded Oculina Bank HAPC) may serve as nursery habitat and protect the stock by providing a refuge for rock shrimp.

Royal Red Shrimp

Although no essential fish habitats of concern have been identified specifically for royal red shrimp, they are caught in association with deep water corals on the continental slope. Deep sea corals support high levels of marine biodiversity by providing habitat for numerous benthic species. As structure-forming animals, deep sea corals enhance habitat complexity by growing in the form of "reefs," fans, stalks, and "bushes." The *Enallopsamia* reefs off South Carolina, the *Oculina* habitat off Florida, and the *Lophelia* reefs from North Carolina to Florida may be important in the life history of royal red shrimp. Bottom impacting mobile gear such as trawls will likely impact these important habitats.

To obtain maps of EFH-HAPCs please visit the Council's Internet Map Server on the South Atlantic Council's website at www.safmc.net.

7.2.2 Snapper Grouper

7.2.2.1 Essential Fish Habitat

EFH utilized by snapper grouper species in this region includes coral reefs, live/hard bottom, submerged aquatic vegetation, artificial reefs and medium to high profile outcroppings on and around the shelf break zone from shore to at least 183 meters [600 feet (but to at least 2,000 feet for wreckfish)] where the annual water temperature range is sufficiently warm to maintain adult populations of members of this largely tropical fish complex. EFH includes the spawning area in the water column above the adult habitat and the additional pelagic environment, including Sargassum, required for survival of larvae and growth up to and including settlement. In addition, the Gulf Stream is also EFH because it provides a mechanism to disperse snapper grouper larvae.

For specific life stages of estuarine dependent and near shore snapper grouper species, EFH includes areas inshore of the 30 meters (100-foot) contour, such as attached macroalgae; submerged rooted vascular plants (seagrasses); estuarine emergent vegetated wetlands (saltmarshes, brackish marsh); tidal creeks; estuarine scrub/shrub (mangrove fringe); oyster reefs and shell banks; unconsolidated bottom (soft sediments); artificial reefs; and coral reefs and live/hard bottom habitats.

7.2.2.2 Essential Fish Habitat-Habitat Areas of Particular Concern

Areas which meet the criteria for essential fish habitat-habitat areas of particular concern (EFH-HAPCs) for species in the snapper grouper management unit include medium to high profile offshore hard bottoms where spawning normally occurs; localities of known or likely periodic spawning aggregations; near shore hard bottom areas; The Point, The Ten Fathom Ledge, and Big Rock (North Carolina); The Charleston Bump (South Carolina); mangrove habitat; seagrass habitat; oyster/shell habitat; all coastal inlets; all state-designated nursery habitats of particular importance to snapper grouper (e.g., Primary and Secondary Nursery Areas designated in North Carolina); pelagic and benthic Sargassum; Hoyt Hills for wreckfish; the Oculina Bank Habitat Area of Particular

Concern; all hermatypic coral habitats and reefs; manganese outcroppings on the Blake Plateau; and Council-designated Artificial Reef Special Management Zones (SMZs). Areas that meet the criteria for designating essential fish habitat-habitat areas of particular concern include habitats required during each life stage (including egg, larval, postlarval, juvenile, and adult stages).

Section 600.815 (a) (8) of the final rule on essential fish habitat determinations recognizes that subunits of EFH may be of particular concern. Such areas, termed Essential Fish Habitat- Habitat Areas of Particular Concern (EFH-HAPCs), can be identified using Identification of habitat areas of particular concern. FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern based on one or more of the following considerations: (i) The importance of the ecological function provided by the habitat; (ii) The extent to which the habitat is sensitive to human-induced environmental degradation; (iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type; and (iv) The rarity of the habitat type. The following is a summary evaluation of the EFH-HAPC as it relates to the criteria:

Table 7.2-2. EFH-HAPC and Criteria Evaluation, Snapper Grouper

EFH-HAPC and Criteria Evaluation	Ecological Function	Sensitivity to Environmental Degradation	Threat from Development Activities	Rarity of Habitat
The Point, NC	Medium	Low	Medium	High
The Ten Fathom Ledge, NC	High	Low	Low	High
Big Rock, NC	High	Low	Medium	High
Charleston Bump, SC	High	Low	Medium	High
Mangrove habitat	High	High	High	High
Seagrass habitat	High	High	High	High
Oyster/shell habitat	High	Medium	High	High
All coastal inlets	Medium	Low	Medium	Medium
All state-designated nursery habitats	High	High	High	Hugh
Pelagic and benthic Sargassum	High	Low	Low	High
Hoyt Hills (wreckfish)	High	Low	Medium	High
Oculina HAPC, FL	High	Medium	Low	High
All hermatypic coral habitats and reefs	High	High	Low	High
Manganese outcroppings of the Blake Plateau	High	Low	Medium	High
Artificial reef SMZs	Medium	Low	Low	High

To obtain maps of EFH-HAPCs please visit the Council's Internet Map Server on the South Atlantic Council's website at www.safmc.net.

7.2.3 Coastal Migratory Pelagics

7.2.3.1 Essential Fish Habitat

Essential fish habitat for coastal migratory pelagic species includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf stream shoreward, including Sargassum. In addition, all coastal inlets, all state-designated nursery habitats of particular importance to coastal migratory pelagics (for example, in North Carolina this would include all Primary Nursery Areas and all Secondary Nursery Areas).

For Cobia essential fish habitat also includes high salinity bays, estuaries, and seagrass habitat. In addition, the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse coastal migratory pelagic larvae.
For king and Spanish mackerel and cobia essential fish habitat occurs in the South Atlantic and Mid-Atlantic Bights.

Refer to Section 3.0 in the Habitat Plan for a more detailed description of habitat utilized by the managed species. Also, it should be noted that the Gulf Stream occurs within the EEZ.

7.2.3.2 Essential Fish Habitat-Habitat Areas of Particular Concern

Areas which meet the criteria for essential fish habitat-habitat areas of particular concern (EFH-HAPCs) include sandy shoals of Capes Lookout, Cape Fear, and Cape Hatteras from shore to the ends of the respective shoals, but shoreward of the Gulf stream; The Point, The Ten-Fathom Ledge, and Big Rock (North Carolina); The Charleston Bump and Hurl Rocks (South Carolina); The Point off Jupiter Inlet (Florida); *Phragmatopoma* (worm reefs) reefs off the central east coast of Florida; nearshore hard bottom south of Cape Canaveral; The Hump off Islamorada, Florida; The Marathon Hump off Marathon, Florida; The “Wall” off of the Florida Keys; Pelagic Sargassum; and Atlantic coast estuaries with high numbers of Spanish mackerel and cobia based on abundance data from the ELMR Program. Estuaries meeting this criteria for Spanish mackerel include Bogue Sound and New River, North Carolina: Bogue Sound, North Carolina (Adults May-September salinity >30 ppt); and New River, North Carolina (Adults May-October salinity >30 ppt). For Cobia they include Broad River, South Carolina; and Broad River, South Carolina (Adults & juveniles May-July salinity >25ppt).

Section 600.815 (a) (8) of the final rule on essential fish habitat determinations recognizes that subunits of EFH may be of particular concern. Such areas, termed Essential Fish Habitat- Habitat Areas of Particular Concern (EFH-HAPCs), can be identified using Identification of habitat areas of particular concern. FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern based on one or more of the following considerations: (i) The importance of the ecological function provided by the habitat; (ii) The extent to which the habitat is sensitive to human-induced environmental degradation; (iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type; and (iv) The rarity of the habitat type. The following is a summary evaluation of the EFH-HAPC as it relates to the criteria:

Table 7.2-3. EFH-HAPC and Criteria Evaluation, Coastal Migratory Pelagics

EFH-HAPC and Criteria Evaluation	Ecological Function	Sensitivity to Environmental Degradation	Threat from Development Activities	Rarity of Habitat
Sandy shoals of Cape Lookout, Cape Fear and Cape Hatteras (from shore to the end of shoals but shoreward from Gulf Stream)	Medium	Low	Medium	Medium
The Point, NC	Medium	Low	Medium	High
The Ten Fathom Ledge, NC	Medium	Low	Medium	Medium
Big Rock, NC	Medium	Low	Low	Medium
Charleston Bump, SC	Medium	Low	Medium	Medium
Hurl Rocks, SC	Medium	Low	Medium	Medium
The Point off Jupiter Inlet, FL	Medium	Low	Low	Low
Phragmatopoma (worm reefs) reefs off the central east coast of FL	High	Medium	Medium	High
nearshore hard bottom south of Cape Canaveral, FL	High	High	High	High
The Hump off Islamorada, FL	Medium	Low	Low	Medium
The Marathon Hump, FL	High	Low	Low	Medium
Hoyt Hills (wreckfish)	Medium		High	Medium
Pelagic Sargassum	High	Low	Low	Medium
Atlantic coast estuaries with high numbers of Spanish mackerel and cobia based on abundance data from the ELMR Program	High	High	High	Medium
Bogue Sound and New River estuaries, NC (Spanish mackerel)	High	High	High	Medium
Broad River, SC (cobia)	High	High	High	Medium

To obtain maps of EFH-HAPCs please visit the Council's Internet Map Server on the South Atlantic Council's website at www.safmc.net.

7.2.4 Golden Crab

7.2.4.1 Essential Fish Habitat

Essential fish habitat for golden crab includes the U.S. Continental Shelf from Chesapeake Bay south through the Florida Straits (and into the Gulf of Mexico). In addition, the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse golden crab larvae. The detailed description of seven essential fish habitat types (a flat foraminferan ooze habitat; distinct mounds, primarily of dead coral; ripple habitat; dunes; black pebble habitat; low outcrop; and soft-bioturbated habitat) for golden crab is provided in Wenner et al. (1987).

Refer to Section 3.0 in the Habitat Plan for a more detailed description of habitat utilized by the managed species. Also, it should be noted that the Gulf Stream occurs within the EEZ.

7.2.4.2 Essential Fish Habitat-Habitat Areas of Particular Concern

There is insufficient knowledge of the biology of golden crabs to identify spawning and nursery areas and to identify HAPCs at this time. As information becomes available, the Council will evaluate such data and identify HAPCs as appropriate through the framework.

7.2.5 Spiny Lobster

7.2.5.1 Essential Fish Habitat

Essential fish habitat for spiny lobster includes nearshore shelf/oceanic waters; shallow subtidal bottom; seagrass habitat; unconsolidated bottom (soft sediments); coral and live/hard bottom habitat; sponges; algal communities (Laurencia); and mangrove habitat (prop roots). In addition the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse spiny lobster larvae.

Refer to Section 3.0 in the Habitat Plan for a more detailed description of habitat utilized by the managed species. Also, it should be noted that the Gulf Stream occurs within the EEZ.

7.2.5.2 Essential Fish Habitat-Habitat Areas of Particular Concern

Areas which meet the criteria for essential fish habitat-habitat areas of particular concern (EFH-HAPCs) for spiny lobster include Florida Bay, Biscayne Bay, Card Sound, and coral/hard bottom habitat from Jupiter Inlet, Florida through the Dry Tortugas, Florida.

Table 7.2-4. EFH-HAPC and Criteria Evaluation, Spiny Lobster

EFH-HAPC and Criteria Evaluation	Ecological Function	Sensitivity to Environmental Degradation	Threat from Development Activities	Rarity of Habitat

Florida Bay	High	High	Medium	Medium
Biscayne Bay	High	High	Medium	Medium
Card Sound	High	High	Medium	Medium
Coral/hardbottom habitat from Jupiter Inlet through the Dry Tortugas, FL	High	High	High	High

To obtain maps of EFH-HAPCs please visit the Council's Internet Map Server on the South Atlantic Council's website at www.safmc.net.

7.2.6 Coral, Coral Reefs and Live/Hard Bottom Habitat

7.2.6.1 Essential Fish Habitat

Essential fish habitat for corals (stony corals, octocorals, and black corals) must incorporate habitat for over 200 species. EFH for corals include the following:

A. Essential fish habitat for hermatypic stony corals includes rough, hard, exposed, stable substrate from Palm Beach County south through the Florida reef tract in subtidal to 30 m depth, subtropical (15°-35° C), oligotrophic waters with high (30 35o/oo) salinity and turbidity levels sufficiently low enough to provide algal symbionts adequate sunlight penetration for photosynthesis. Ahermatypic stony corals are not light restricted and their essential fish habitat includes defined hard substrate in subtidal to outer shelf depths throughout the management area.

B. Essential fish habitat for Antipatharia (black corals) includes rough, hard, exposed, stable substrate, offshore in high (30-35o/oo) salinity waters in depths exceeding 18 meters (54 feet), not restricted by light penetration on the outer shelf throughout the management area.

C. Essential fish habitat for octocorals excepting the order Pennatulacea (sea pens and sea pansies) includes rough, hard, exposed, stable substrate in subtidal to outer shelf depths within a wide range of salinity and light penetration throughout the management area.

D. Essential fish habitat for Pennatulacea (sea pens and sea pansies) includes muddy, silty bottoms in subtidal to outer shelf depths within a wide range of salinity and light penetration.

Refer to Section 3.0 in the Habitat Plan for a more detailed description of habitat utilized by the managed species.

7.2.6.2 Essential Fish Habitat-Habitat Areas of Particular Concern

Areas which meet the criteria for essential fish habitat-habitat areas of particular concern (EFH-HAPCs) for coral, coral reefs, and live/hard bottom include The 10-Fathom Ledge, Big Rock, and The Point (North Carolina); Hurl Rocks and The Charleston Bump (South Carolina); Gray's Reef National Marine Sanctuary (Georgia); The *Phragmatopoma* (worm reefs) reefs off the central east coast of Florida; Oculina Banks off the east coast of Florida from Ft. Pierce to Cape Canaveral; nearshore (0-4 meters; 0-12 feet) hard bottom off the east coast of Florida from Cape Canaveral to Broward County; offshore (5-30 meter; 15-90 feet) hard bottom off the east coast of Florida from Palm Beach County to Fowey Rocks; Biscayne Bay, Florida; Biscayne National Park, Florida; and the Florida Keys National Marine Sanctuary.

Table 7.2-5. EFH-HAPC and Criteria Evaluation, Coral, Coral Reefs, and Live/Hard Bottom Habitat

EFH-HAPC and Criteria Evaluation	Ecological Function	Sensitivity to Environmental Degradation	Threat from Development Activities	Rarity of Habitat
Ten Fathom Ledge, NC	Medium	Low	Medium	Medium
Big Rock, NC	Medium	Low	Medium	Medium
The Point, NC	Medium	Low	Medium	Medium
Hurl Rocks, SC	Medium	High	High	Medium
Charleston Bump, SC	Medium	Low	Medium	Medium
Gray's Reef NMS, GA	High	Low	Low	Medium
Phragmatopoma worm reefs, FL	Medium	High	Medium	High
Oculina Banks from Ft. Pierce to Cape Canaveral, FL	High	Low	Low	High
Nearshore hardbottom off from Cape Canaveral to Broward County, FL	High	Medium	High	Medium
Offshore hardbottom from Palm Beach County to Fowey Rocks, FL	High	Low	Medium	Medium
Biscayne Bay, FL	Medium	Low	Medium	Medium
Biscayne National Park, FL	Medium		Medium	Low
Florida Keys NMS, FL	High	High	High	High

To obtain maps of EFH-HAPCs please visit the Council's Internet Map Server on the South Atlantic Council's website at www.safmc.net.

7.2.7 Dolphin Wahoo

7.2.7.1 Essential Fish Habitat

EFH for dolphin and wahoo is the Gulf Stream, Charleston Gyre, Florida Current, and pelagic Sargassum.

Note: This EFH definition for dolphin was approved by the Secretary of Commerce on June 3, 1999 as a part of the South Atlantic Council's Comprehensive Habitat Amendment (SAFMC, 1998b) (dolphin was included within the Coastal Migratory

Pelagics FMP). This definition does not apply to extra-jurisdictional areas. A detailed description of the pelagic habitats used by dolphin and wahoo is presented in Section 3.0 Affected Environment.

7.2.7.2 Essential Fish Habitat-Habitat Areas of Particular Concern

EFH-HAPCs for dolphin and wahoo in the Atlantic include The Point, The Ten-Fathom Ledge, and Big Rock (North Carolina); The Charleston Bump and The Georgetown Hole (South Carolina); The Point off Jupiter Inlet (Florida); The Hump off Islamorada, Florida; The Marathon Hump off Marathon, Florida; The "Wall" off of the Florida Keys; and Pelagic Sargassum.

Note: This EFH-HAPC definition for dolphin was approved by the Secretary of Commerce on June 3, 1999 as a part of the South Atlantic Council's Comprehensive Habitat Amendment (dolphin was included within the Coastal Migratory Pelagics FMP).

Section 600.815 (a) (8) of the final rule on essential fish habitat determinations recognizes that subunits of EFH may be of particular concern. Such areas, termed Essential Fish Habitat- Habitat Areas of Particular Concern (EFH-HAPCs), can be identified using Identification of habitat areas of particular concern. FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern based on one or more of the following considerations: (i) The importance of the ecological function provided by the habitat; (ii) The extent to which the habitat is sensitive to human-induced environmental degradation; (iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type; and (iv) The rarity of the habitat type. The following is a summary evaluation of the EFH-HAPC as it relates to the criteria:

Table 7.2-6. EFH-HAPC and Criteria Evaluation, Dolphin Wahoo

EFH-HAPC and Criteria Evaluation	Ecological Function	Sensitivity to Environmental Degradation	Threat from Development Activities	Rarity of Habitat
The Point	High	Medium	Medium	High
The Ten Fathom Ledge	High	Medium	Low	Medium
Big Rock	High	Medium	Medium	High
The Charleston Bump	High	Low	Medium	High
The Georgetown Hole	High	Low	Low	High
The Point off Jupiter Inlet	High	Medium	Low	High
The Hump off Islamorada	High	Low	Low	High
The Marathon Hump	High	Medium	Low	High
The Wall off of the Florida Keys	Medium	Medium	Low	Medium
Pelagic *Sargassum*	High	Medium	Low	High

The proposed EFH-HAPCs for dolphin and wahoo all meet at least one or more of the above criteria. This action enables the Councils to protect these EFH-HAPCs effectively and take timely actions when necessary. This could prevent further decreases in biological productivity and may lead to possible increases in yield of fish stocks. This evaluation is based in part on information presented in this Action and Section 3.3.1.2.1 describing the general characteristics of the unique habitat type and where available specific descriptions of the habitat associated with the area proposed for designation as an EFH-HAPC. In addition, supporting rationale for designation including identified threats from fishing and non-fishing activities is presented in Habitat Plan (SAFMC, 1998b), the Comprehensive Habitat Amendment (SAFMC, 1998c) and the Sargassum Fishery Management Plan (SAFMC 2002) and included by reference. The following figures present maps for areas which for dolphin and wahoo ranked high in terms of ecological function, sensitivity, probability of stressor introduction and rarity of habitat (criteria established for designation of EFH-HAPCs). Based on the criteria in Section 600.815 (a) (9), it is concluded that they represent Essential Fish Habitat-Habitat Areas of Particular Concern for species managed under the Fishery Management Plan for Dolphin Wahoo of the Atlantic Region.

To obtain maps of EFH-HAPCs please visit the Council's Internet Map Server on the South Atlantic Council's website at www.safmc.net.

7.2.8 Other managed species in the South Atlantic

7.2.8.1 Atlantic Menhaden

(from Atlantic Menhaden FMP; ASMFC 2001)

Essential Fish Habitat

Almost all of the estuarine and nearshore waters along the Atlantic coast from Florida to Nova Scotia, serve as important habitat for juvenile and/or adult Atlantic menhaden. Spawning occurs in oceanic waters along the Continental Shelf, as well as in sounds and bays in the northern extent of their range (Judy and Lewis 1983). Larvae are carried by inshore currents into estuaries from May to October in the New England area, from October to June in the mid-Atlantic area, and from December to May in the south Atlantic area (Reintjes and Pacheco 1966). After entering the estuary, larvae congregate in large concentrations near the upstream limits of the tidal zone, where they undergo metamorphosis into juveniles (June and Chamberlin 1959). The relative densities of juvenile menhaden have been shown to be positively correlated with higher chlorophyll a levels in the lower salinity zones of estuaries (Friedland et al. 1996). As juvenile menhaden grow and develop, they form dense schools and range throughout the lower salinity portions of the estuary, most eventually migrating to the ocean in late fall-winter. Many factors in the estuarine environment affect the behavior and well-being of menhaden. The combined influence of weather, tides, and river flow can expose estuarine fish to rapid changes in temperature and salinity. It has been reported that salinity affects menhaden temperature tolerance, activity and metabolic levels, and growth (Lewis 1966; Hettler 1976). Factors such as waves, currents, turbidity, and dissolved oxygen levels can impact the suitability of the habitat, as well as the distribution of fish and their feeding behavior (Reintjes and Pacheco 1966). However, the most important factors affecting natural mortality in Atlantic menhaden are considered to be predators, parasites and fluctuating environmental conditions (Reish et al. 1985).

It is clearly evident that estuarine and coastal areas along the Atlantic coast provide essential habitat for most life stages of Atlantic menhaden. However, an increasing number of people live near the coast, which precipitates associated industrial and municipal expansion, thus, accelerating competition for use of the same habitats. Consequently, estuarine and coastal habitats have been significantly reduced and continue to be stressed adversely by dredging, filling, coastal construction, energy plant development, pollution, waste disposal, and other human-related activities.

Estuaries of the mid-Atlantic and south Atlantic states provide almost all of the nursery areas utilized by Atlantic menhaden. Areas such as Chesapeake Bay and the Albemarle-Pamlico system are especially susceptible to pollution because they are generally shallow, have a high total volume relative to freshwater inflow, low tidal exchange, and a long retention time. Most tributaries of these systems originate in the Coastal Plain and have relatively little freshwater flow to remove pollutants. Shorelines of most estuarine areas are becoming increasingly developed, even with existing habitat protection programs. Thus, the specific habitats of greatest long-term importance to the menhaden stock and fishery are increasingly at risk.

7.2.8.2 Anadromous and Catadromous Species

Alosine species (from ASMFC habitat docs on anadromous species)
Essential Fish Habitat-Habitat Areas of Particular Concern
Habitats described as EFH for other managed species (spawning adult, egg, larval, juvenile, sub-adult, and adult resident and migratory) are deemed essential to the sustainability of anadromous alosine stocks as they presently exist. Nursery habitat for anadromous alosines consists of areas in which the larvae, postlarvae, and juveniles grow and mature. These areas include the spawning grounds and areas through which the larvae and postlarvae drift after hatching, as well as the portions of rivers and adjacent estuaries in which they feed, grow, and mature. Juvenile alosines, which leave the coastal bays and estuaries prior to reaching adulthood also use the nearshore Atlantic Ocean as a nursery area (ASMFC 1999).

Sub-adult and adult habitat for alosines consists of the nearshore Atlantic Ocean from the Bay of Fundy, Canada to Florida; inlets, which provide access to coastal bays and estuaries; and riverine habitat upstream to the spawning grounds (ASMFC 1999). American shad and river herring have similar seasonal distributions, which may be indicative of similar inshore and offshore migratory patterns (Neves 1981). Although the distribution and movements of hickory shad are essentially unknown after they return to the ocean, (Richkus and DiNardo 1984) because they are harvested along the southern New England coast in the summer and fall, (Bigelow and Schroeder 1953) it is assumed that they also follow a migratory pattern similar to American shad (Dadswell et al. 1987).

Klauda et al. (1991) concluded that the critical life history stages for American shad, hickory shad, alewives, and blueback herring are the egg, prolarva (yolk-sac or prefeeding larva), postlarva (feeding larva), and early juvenile (through the first month after transformation). Critical habitat in the state of North Carolina is defined as “The fragile estuarine and marine areas that support juvenile and adult populations of economically important seafood species, as well as forage species important in the food chain." Among these critical habitats are anadromous fish spawning and anadromous nursery areas, in all coastal fishing waters (NCAC 3I.0101 (20) (NCDEHNR 1997). Although most states have not formally designated essential or critical alosine habitat areas, most states have identified spawning habitat, and some have even identified nursery habitat.

Tables 1-4 summarize significant environmental, temporal, and spatial factors that affect the distribution of American shad, hickory shad, alewife, and blueback herring. Tables 5-8 contain confirmed, reported, suspected, or historical state habitat for American shad, hickory shad, alewife, and blueback herring. Appendix C contains information about past, current, or proposed actions to restore alosine habitat by state. Appendix D contains a discussion of habitat in the Exclusive Economic Zone (EEZ) and international waters. Alosines spend the majority of their life cycle outside of state waters, and the Commission recognizes that all habitats used by these species are essential to their existence.

American eel

Essential Fish Habitat-Habitat Areas of Particular Concern

Habitat types that qualify as Habitat Areas of Particular Concern for American eel include the spawning and hatching area, nursery and juvenile habitat, and adult habitat.

Ocean - The spawning and hatching area for American eel occurs in the oceanic waters of the Sargasso Sea. This is the only suspected location of reproduction for American eel, and therefore, is essential to the survival of the species. Little is known about American eel habitat in the Sargasso Sea, and the exact location of spawning and hatching has not been identified.

Continental Shelf - The Continental shelf waters are important to the American eel because it is final stage of the larval eel migration route, where eels begin entering coastal waters, and is important to larval feeding and growth. It is also where American eel metamorphose into the glass eel stage.

Estuaries/Freshwater Habitat – Estuaries and any upstream freshwater habitat, including rivers, streams, and lakes serve as juvenile, sub-adult, and adult migration corridors, as well as feeding and growth areas for juveniles and sub-adults (ASMFC 2000). After American eel larvae transform into glass eels over the continental shelf, they enter estuaries, and ascend the tidal portions of rivers. Glass eels change into the elver life stage and either continue upstream movements, or cease migrating in the lower saline portions of estuaries and rivers. These estuaries and freshwater habitats serve as the foraging grounds for American eels and are important to the eel growth and maturation. American eels can remain in these systems for up to twenty years before maturing and returning to sea.

While estuarine/riverine habitats have been identified as important for the rearing and growth of American eels, many studies have failed to find specific American eel-habitat associations within them (Huish and Pardue 1978; Meffe and Sheldon 1988; Smogor et al. 1995; Bain et al. 1988; Wiley et al. 2004). Huish and Pardue (1978) found no difference in American eel abundance in relation to width, substrate, flow, and depth in North Carolina streams. Likewise, Bain et al. (1988) found that eel habitat use was not related to specific habitat features including depth, water velocity, and substrate in two Connecticut River tributaries. Wiley et al. (2004) also did not find any eel-stream habitat relations. They found that eel density was correlated with distance from the ocean. Since eels have the ability to survive in a wide variety of habitats, the phase of their lives when they live in estuarine, riverine, stream, and lake habitats are less limited, but water quality is an important factor in their health and survival.

Given the great variation in demographics that occurs across latitudinal and distance-inland gradients, it's unlikely that all areas contribute equally to eel production/recruitment. Despite this, geographic patterns of differential recruitment are unexplored. This problem needs to be addressed before identifying specific Habitat Areas of Particular Concern.

7.2.8.3 Red Drum

Essential Fish Habitat

For red drum, essential fish habitat includes all the following habitats to a depth of 50 meters offshore: tidal freshwater; estuarine emergent vegetated wetlands (flooded saltmarshes, brackish marsh, and tidal creeks); estuarine scrub/shrub (mangrove fringe); submerged rooted vascular plants (sea grasses); oyster reefs and shell banks; unconsolidated bottom (soft sediments); ocean high salinity surf zones; and artificial reefs. The area covered includes Virginia through the Florida Keys.

Essential Fish Habitat-Habitat Areas of Particular Concern

Areas which meet the criteria for essential fish habitat-habitat areas of particular concern (EFH-HAPCs) for red drum include all coastal inlets, all state-designated nursery habitats of particular importance to red drum (for example, in North Carolina this would include all Primary Nursery Areas and all Secondary Nursery Areas); documented sites of spawning aggregations in North Carolina, South Carolina, Georgia, and Florida described in the Habitat Plan; other spawning areas identified in the future; and habitats identified for submerged aquatic vegetation.

To obtain maps of EFH-HAPCs please visit the Council's Internet Map Server on the South Atlantic Council's website at www.safmc.net.

7.2.8.4 Weakfish and other Sciaenid Species

7.2.8.5 Bluefish

(Source: EFH Source Document (NEFSC 2006).)

Table 7.2-7. Summary of life history and habitat characteristics for bluefish, *Pomatomus saltatrix*.

Life History Stage	Habitat (Spatial and Temporal)	Temperature	Salinity	Light/Vertical Distribution	Currents/ Circulation	Prey	Estuarine Use
Eggs [1]	*spring cohort*: unknown. *summer cohort*: occurs across continental shelf, southern New England to Cape Hatteras. Most in mid-shelf waters.	*spring cohort*: unknown. *summer cohort*: most in 18-22°C.	*spring cohort*: unknown. *summer cohort*: 31.0 ppt or more (minimum 26.0 ppt).	*spring cohort*: unknown. *summer cohort*: peak spawning in the evening (1900-2100 hrs).	*spring cohort*: unknown. *summer cohort*: in southern MAB, surface currents transport eggs south and offshore.	--	None
Larvae [2]	*spring cohort*: near edge of continental shelf, Cape Hatteras-Cape Canaveral, FL. Peak April-May. *summer cohort*: most 30-70 m depths, May-Sept, peak in July.	*spring cohort*: smallest larvae in > 24°C. *summer cohort*: near Cape Hatteras 22.1-22.4°C; in MAB 18-26°C.	*spring cohort*: smallest larvae in > 35 ppt. *summer cohort*: in MAB in 30-32 ppt.	*spring cohort*: > 4 mm strongly associate with surface. *summer cohort*: near surface at night, mostly at about 4 m during day.	*spring cohort*: subject to northward advection by Gulf Stream. Some retained in SAB by southerly counter-current. *summer cohort*: southwest winds in MAB may facilitate cross-shelf transport.	*summer cohort*: mostly copepod life history stages. Guts full during day.	None
Pelagic Juveniles [3]	*spring cohort*: smallest near 180 m contour; larger near shore. April-May. *summer cohort*: cross MAB shelf from Slope Sea to shore, early- to mid-June.	*spring cohort*: 19.0-24.0°C (or higher well offshore). *summer cohort*: in MAB 15.0-20.0°C (most > 18.0°C). As low as 13.0°C when cross shelf.	*spring cohort*: Near 180 m contour, > 35.0 ppt. *summer cohort*: During June, range 36.0-31.0 ppt.	*both cohorts*: strongly associated with the surface.	*spring cohort*: shoreward movement with growth unless advected north. *summer cohort*: move shoreward with growth. Currents important, but active swimming indicated.	--	*both cohorts*: enter estuarine nurseries during this stage
Juveniles [4] *(summer cohort only)*	Several estuarine study areas between Narragansett Bay, RI and Delaware Bay and Delaware River. Also coast beaches and surf zones.	In most studies, arrive > 20°C, remain in temperatures up to 30°C, emigrate when declines to 15°C. Can not survive below 10°C or above 34°C. Fall migration in 18-22°C on inner continental shelf.	Usually 23.0-33.0 ppt but can intrude to as low as 3.0 ppt.	Day: usually near shorelines or in tidal creeks. Night: usually in open bay or channel waters.	Can occur in surf zone or clear to turbid back-estuarine zones.	Atlantic silversides, bay anchovy, clupeids, striped bass, sand shrimp, mysids, other fish, invertebrates.	Mostly sand, particularly along coast, but some mud, silt, clay. Also uses *Ulva*, *Zostera* beds, and *Spartina* or *Fucus*. In Chesapeake Bay includes oyster bars and beds.
Adults [5]	Generally oceanic, nearshore to well offshore over continental shelf.	Warm water, usually > 14-16°C. Can tolerate 11.8-30.4°C but are stressed at either extreme.	Oceanic salinities.	--	--	Sight feeders, prey on other fish almost exclusively.	Not uncommon in bays, larger estuaries, as well as coastal waters.

[1] Norcross et al. (1974); Berrien and Sibunka (1999); data from present report.
[2] Norcross et al. (1974); Kendall and Walford (1979); Kendall and Naplin (1981); Powles (1981); Collins and Stender (1987); Hare and Cowen (1996); data
from present report.
[3] Fahay (1975); Kendall and Walford (1979); Powles (1981); Collins and Stender (1987); Hare and Cowen (1996).
[4] Lund and Maltezos (1970); Olla et al. (1975); Milstein et al. (1977); Nyman and Conover (1988); Rountree and Able (1992a, b); McBride et al. (1995); Able
et al. (1996); Buckel and Conover (1997); Harding and Mann (2001), Buckel and McKown (2002), Secor et al. (2002), Able et al. (2003).
[5] Bigelow and Schroeder (1953); Olla and Studholme (1971).

7.2.8.6 Horseshoe Crab

(from ASMFC's Horseshoe Crab FMP 1998)
Beach areas that provide spawning habitat are considered essential habitats for adult horseshoe crabs. Nearshore, shallow water, intertidal flats are considered essential habitats for the juvenile development. Delaware Division of Fish and Wildlife's 16-foot bottom trawl survey data indicated that over 99 percent of juvenile horseshoe crabs (<160 mm prosomal width) were taken at salinities >5 parts per thousand (Michels, 1997).

Larger juveniles and adults use deep water habitats to forage for food, but these are not considered essential habitat. Of these habitats, the beaches are the most critical (Shuster, 1994). Optimal spawning beaches may be a limiting reproductive factor for the horseshoe crab population. Based on geomorphology Botton, et al. (1992) estimated that only 10 percent of the New Jersey shore adjacent to Delaware Bay provided optimal horseshoe crab spawning habitat. The densest concentrations of horseshoe crabs in New Jersey occur on small sandy beaches surrounded by salt marshes or bulkheaded areas (Loveland et al., 1996).

Prime spawning habitat is widely distributed throughout Maryland's Chesapeake and coastal bays, including tributaries. Horseshoe crabs are restricted to areas that exceed 7 ppt salinity (Maryland Department of Natural Resources, 1998). In the Chesapeake Bay, spawning habitat generally extends to the mouth of the Chester River, but can occur farther north during years of above normal salinity levels. Prime spawning beaches within the Delaware Bay consist of sand beaches between Maurice River and the Cape May Canal in New Jersey and between Bowers Beach and Lewes in Delaware (Shuster, 1994).

7.2.8.7 HMS Species – Species in SA

Tunas

(text below excerpted from the Consolidated HMS FMP, chapter 10, section titled "Tunas" under "Summary of Review and Findings."

In recent years, archival tags and popup satellite tags (PSATs) have been used to successfully monitor ocean-wide movements of giant bluefin tuna as well as other HMS (Block et al., 2001, 2005; Lutcavage et al., 1999). This technology has greatly expanded the understanding of migratory patterns, reproductive behavior, and habitat use for bluefin tuna as well as other HMS such as blue and white marlin (NMFS, 2004). However, despite these advances, there are considerable gaps in the understanding of habitat requirements as they relate to identifying Essential Fish Habitat (EFH) for tunas. Accurate identification of certain species of tunas can be difficult unless one has sufficient knowledge to check for appropriate distinguishing characteristics. This is particularly true for planktonic larval stages of all tuna species and adult stages of bigeye and blackfin tuna. For example, bigeye tuna may easily be mistaken for blackfin or juvenile yellowfin tuna, and can only be positively distinguished from one another by examining the liver and gill rakers. Reviewers raised concerns regarding presence of a high number of bigeye tuna in the Gulf of Mexico, which are rarer than blackfin tuna, and which may have been misidentified. The distribution maps for bigeye tuna indicate a significant number of observations in the Gulf of Mexico that may need to be reviewed and reanalyzed for accuracy prior to any modifications being made to existing boundaries (J. Lamkin, pers. comm.).

The Tag A Giant (TAG) program is a collaborative effort among scientists from Stanford University, the Monterey Bay Aquarium, and NMFS which continues to place electronic tags internally and externally on Atlantic bluefin tuna in the North Atlantic to continuously record data. Tag A Giant deployed 201 archival and 37 pop-up satellite archival tags (PSATs) over the past two years, during which time 21 archival tags were recovered, more than a third of which were recaptured east of the 45 degree management line. The program has collected over 13,000 geopositions obtained from 330 bluefin tuna. It is now possible to examine data in relation to year class, season, and spawning grounds visited. Bluefin tuna tagged in the western Atlantic have migrated to both the Mediterranean and Gulf of Mexico spawning grounds. Most migration to spawning grounds in the Gulf of Mexico occurred in the spring months where spawning fish appear to prefer mesoscale cyclonic eddies in the western Gulf. Results indicate that spawning occurs in the Gulf of Mexico primarily during the months of April to June (Block et al., 2005).

The results attained from the TAG program detail the movements and behaviors of Atlantic bluefin tuna. These data answer questions about habitat preferences, spawning and feeding grounds, spawning site fidelity, the level of mixing between eastern and western stocks, and how movements are influenced by age class and season. Linking biological data with environmental data can assist in understanding relationships between the bluefin's physical environment and its behavior, movements, abundance and distribution, leading to predictive models enabling researchers to estimate the abundance and distribution of bluefin based on oceanographic features, season, and year class. This information is being collected primarily for ICCATs consideration in updating management strategies and quotas that reflect the bluefin tunas life history in the Atlantic Ocean.

Data collected to date consistently show that spawning occurs primarily after the bluefin reach 10 years of age. Bluefin tuna that are 8.5 years and younger tend to remain near New England in the summer and fall whereas older fish move offshore, many traveling to the east of the 45 degree management zone to the Mid-Atlantic Bight and Flemish Cap. Seasonal patterns are also apparent. Bluefin tuna remained in the coastal and offshore waters of North Carolina and the South Atlantic Bight throughout the winter months, predominately over the shallow continental shelf. In the spring, most fish move north depending on age class, where they remain for the summer before returning to the south in the fall. The movements among regions appear to be dependent on temperature.
In 2002 and 2003, the TAG program expanded tagging efforts to New England, off the coast of Nantucket to spread efforts over a broader area. In 2003, efforts were expanded to the eastern Atlantic off the coast of Ireland where the program has obtained the first data on a new group of fish that have not yet been studied with this technology. Deploying tags off Ireland will also increase the likelihood of documenting the behaviors

of fish spawning in the Mediterranean for comparison to those spawning in the Gulf of Mexico. The improved understanding of bluefin movements and behaviors has important applications for management and can serve as the basis for necessary changes in current management strategies.

Beginning in 1997, studies led by the New England Aquarium have implanted pop-up and pop-up archival satellite tags (PSATs) on western Atlantic bluefin tuna. Recent studies involved the implantation of PSATs into 68 Atlantic bluefin tuna in the southern Gulf of Maine and off the coast of North Carolina between July 2002 and January 2003 (Wilson et al., In Press). Most of the fish tagged in the southern Gulf of Maine in late summer/early fall remained in that area until late October, consistent with previous studies. Of the 33, 14 remained in northern shelf waters (between Maryland and Nova Scotia), 14 moved south to waters off the coasts of Virginia and North Carolina, and five were in offshore waters of the northwestern Atlantic Ocean. In the spring, six of the 11 fish either stayed in northern waters or moved to that area from Virginia and North Carolina waters, and the other five fish moved offshore into the Mid-Atlantic Ocean. Similar seasonal movement patterns have been shown by individuals tagged in coastal waters off North Carolina. During the winter months, these fish remained either on the Carolina shelf or in offshore waters of the northwestern Atlantic Ocean and moved offshore along the path of the Gulf Stream in spring. By summer, many were in northern shelf waters.

Swimming depth was significantly correlated with location, season, size class, time of day, and moon phase. The greatest depth recorded was 672 m (2,218 ft), and fish experienced temperatures ranging from 3.4° to 28.7°C (38° to 83.7° F). The data show that Atlantic bluefin tuna spend the majority of their time in the top 20 m (66 ft) of the water column, descending occasionally to depths in excess of 500 m (1,650 ft). The vertical behavior of bluefin tuna differed among locations, with shallower swimming depths occurring when the fish were in inshore waters.

A recent study of the diet and trophic position of bluefin tuna in coastal Massachusetts and the Gulf of Maine used stable isotope analyses to investigate feeding habits of bluefin tuna. The results suggest that bluefin tuna feed on a variety of schooling fish, including silver hake, Atlantic mackerel, and Atlantic herring (Estrada et al., 2005). Juvenile bluefin tuna appear to have isotopic nitrogen signatures similar to those of suspension feeders, suggesting that nektonic crustaceans or zooplankton may contribute significantly to the diet of juvenile bluefin tuna (Estrada et al., 2005).

Combined, all of the studies and data are providing a higher resolution of potential spawning, feeding, and other important habitat areas for bluefin tuna. Given that there is a considerable and growing body of science on bluefin tuna, it may be one of the species for which NMFS may consider modifying the boundaries in the future. For example, although bluefin tuna spawning habitat has been described as encompassing nearly all of the Gulf of Mexico by Block et al. (2005), adult bluefin tuna EFH is limited to a smaller portion of the western Gulf of Mexico, and the adult EFH areas may not necessarily correspond to areas considered most likely as bluefin tuna spawning habitat (Block et. al., 2005). NMFS may need to reconsider these boundaries to account for new information being developed through PSAT technology and other means. Similarly, some of the highest individual counts of adult bluefin tuna (per 100 nm2) have been observed off of North Carolina, yet these areas are not currently included as adult bluefin tuna EFH. Furthermore, the SEFSC is currently conducting a comprehensive review of larval distributions from 1984 to the present from ichthyoplankton collections in the northern Gulf of Mexico. Once larval movement due to local currents is accounted for these data may prove useful in the review of potential modification of EFH boundaries for other tunas as well.

In addition, the distribution and abundance of other tuna species (i.e., albacore, bigeye, skipjack, and yellowfin tunas) have been attained through fishery data combined with other information, such as remote sensing data. Many of these species have similar bioecological responses (i.e., many species are specialized in high energy foraging strategies of sustained fast swimming, searching over large areas (Sharp and Dizon, 1978; Au 1986)) and therefore, have similar physiological responses to oceanographic conditions (Ramos et al., 1996). Skipjack and albacore are highly migratory tunas with active thermic exchanges with the environment (Sharp and Dizon, 1978). Consequently, their distribution is influenced by changes in marine features at different spatial and temporal scales (Ramos et al., 1996). For instance, both species are visual predators and are unable to efficiently capture small pelagic prey in colder turbid upwelled waters (Ramos et al., 1996). Therefore, over small spatial and temporal scales, the most suitable areas based on the physiology and feeding strategies for these two species are the boundary between warm and cold water where food and other abiotic features are physiologically optimal (Ramos et al., 1996). Over longer temporal and spatial scales, such as migration pathways, sea surface temperatures generated by the Intertropical Zone of Convergence play an important role (Ramos et al., 1996). In addition, concentration of food and water quality (i.e., higher temperature, high concentration of oxygen and low level of turbidity) lead to the concentration of skipjack and albacore in their respective fishing grounds (the northeast Atlantic for albacore and Senegal waters 10° North to the Canarian area 28° North for skipjack; Ramos et al., 1996).

Yellowfin tuna is a cosmopolitan species mainly distributed in the tropical and subtropical oceanic water of the three oceans. In the Atlantic Ocean, tagging and catch-at-size data analyses have shown that yellowfin tuna move at different scales in the whole tropical Atlantic Ocean (Maury et al., 2001). Environmental conditions are probably the main causes driving migration phenomena and massive population movements (Mendelssohn and Roy, 1986; Lehodey et al., 1997). Recent work by Maury et al. (2001) showed that on a large spatiotemporal scale (the whole ocean), low salinity was a good predictor of yellowfin habitat. Juveniles were mainly distributed in low-salinity waters (< 35 parts per thousand) whereas adults extend their range to water of 36 parts per thousand. This can be due to two reasons; for young tuna (<3 yrs old), salinity could be a marker of favorable feeding areas, such as low salinity levels in the Gulf of Guinea where freshwater runoff contains high levels of nutrients. Secondly, the metabolic cost of osmotic regulation could prevent young yellowfin tuna from reaching high salinity levels (Maury et al., 2001). After breeding in the Gulf of Guinea, adults, however, disperse in an east-west fashion related to salinity and warmwater seasonal oscillations (Maury et al., 2001). On a mesoscale (1000 km), north-south seasonal movements are clearly related to warmwater seasonal oscillations. Such seasonal migrations should be due to surface water temperatures where adults preferentially stay in zones of water temperature between 26 to 29° C and where deeper waters are warmer than 15° C. Juveniles stay in surface waters where the sea surface temperature is 27° C or higher (Maury et al., 2001). Finally, at the local level (100 km), yellowfin tuna seem to be influenced by both local hydrological and biological features, such as tuna prey distribution and the spatial stability of water masses. For instance, the presence of floating objects, and the existence of small-scale hydrological events like local fronts or convergences can all be responsible for yellowfin concentrations (Bakun 1996).

Lastly, bigeye tuna are large epi-and mesopelagic fish that are found in surface waters ranging in temperatures from 13 to 29°C (Collette and Nauen, 1983). However major concentrations coincide with the temperature range of the permanent thermocline, between 17 and 22°C. Therefore, temperature and thermocline depth appear to be important environmental factors governing the vertical and horizontal distribution of bigeye tuna (Alvarado Bremer et al., 1998). Such oceanographic features can have important implications for fisheries management; for instance, water temperature can prevent movement of fish between ocean basins, influencing stock structure (Alvarado Bremer et al., 1998). On the basis of fisheries data, geographic distribution, tagging results, and the location of spawning and nursery areas, a single population is assumed to inhabit the Atlantic Ocean (ICCAT, 1997). For management purposes, both the Indian Ocean and Pacific populations are considered to be single units. Recent molecular work has indicated that the Atlantic and Indo-Pacific populations are two regions and genetically distinct (Alvarado Bremer et al., 1998), confirming a single spawning stock of bigeye in the Atlantic and a single spawning stock in the Indo-Pacific. In the Atlantic Ocean, juvenile bigeye tuna have been observed only in the Gulf of Guinea (ICCAT, 1997). Tagging studies indicate trans-Atlantic movements of bigeye from the Gulf of Guinea to the central Atlantic north of Brazil, and northerly migration from the Gulf of Guinea to the eastern Atlantic (ICCAT, 1997).

As with most other HMS, salinity and temperature appear to be primary factors influencing the distribution of tunas and may ultimately determine EFH. The challenge remains in identifying specific EFH areas based solely on environmental parameters; in most cases, distribution data may still provide the best indication of habitat preference of these different species.

Swordfish

(text below excerpted from the Consolidated HMS FMP, chapter 10, section titled "Swordfish" under "Summary of Review and Findings."

Based on a review of the swordfish maps and current distribution points, reviewers commented that additional research may be needed to validate the current size ranges for juvenile and adult swordfish. In addition, further analysis may be needed to determine whether certain areas have been used consistently over time. Analyzing spawning areas that are consistently used over a number of years may provide a better understanding of swordfish EFH. Several discrepancies in distribution points and EFH areas delineated in 1999 were noted, including a high concentration of observed occurrences of juvenile swordfish in an area north of Long Island Sound that was not defined as EFH in 1999. NMFS may consider modifying swordfish EFH boundaries in the future, particularly in the Long Island Sound area, and conversely, areas currently delineated as EFH that have few if any observed occurrences in the data sets being analyzed.

Pinpointing definitive EFH for spawning swordfish is difficult because research indicates that presence of larvae may not always be a sign that spawning occurred in the vicinity of the collection. Adult swordfish, and HMS in general, may move significant distances during spawning, and eggs and larvae may be transported substantial distances by currents as well. Govoni et. al. (2000) determined that since a swordfish egg's incubation period is 3 days at 24°C, with an additional three or four days for posthatch growth, along with an average velocity of the Gulf Stream of 1.5 m/s (Olson et al., 1994), larvae of four to five mm SL in the Atlantic could have been transported from as far away as 900 km. A similar trajectory was projected for small larvae of bluefin tuna (McGowan and Richards, 1989).

Billfish

Similar to other HMS, billfish EFH is not easily identified due to a lack of association with readily identifiable features such as benthic habitat or other underwater structures. Billfish tend to aggregate in areas with dynamic features such as temperature gradients, ocean fronts or currents resulting from interactions between a number of factors. Many of these water column features are dynamic, making detailed delineation of billfish spawning, nursery, and feeding habitats difficult. Adding to the difficulty of designating billfish EFH is that most of the literature on billfish larvae and juveniles mention them as incidental catches in studies that were directed at other species or that were concerned with characterizing ichthyofaunal or plankton communities as a whole (NMFS, 2004). Comments received during the Draft FMP indicate that *Sargassum* may be an important component of billfish habitat, particularly during early life stages, and that NMFS should investigate this further. If NMFS determines that EFH for some or all HMS needs to be modified, then that would be addressed in a subsequent rulemaking, at which point *Sargassum* could also be considered as potential EFH. With regard to harvest, the final South Atlantic Fishery Management Council FMP for Pelagic *Sargassum* Habitat in the South Atlantic Region was approved in 2003 and implemented strict restrictions on commercial harvest of Sargassum. The approved plan includes strong limitations on future commercial harvest. Restrictions include prohibition of harvest south of the NC/SC state boundary, a total allowable catch (TAC) of 5,000 pounds wet weight per year, limiting harvest to November through June to protect turtles, requiring observers onboard any vessel harvesting *Sargassum*, prohibiting harvest within 100 miles of shore, and gear specifications.

One of the key issues associated with delineating billfish EFH is the difficulty of accurately identifying billfish larvae. However, new molecular techniques are being developed that show promise (Luthy et al., 2005). Without accurate identification of larvae, it is difficult to draw conclusions on spawning areas, habitat associations, and requirements. Billfish larvae may be swept miles from actual spawning grounds before they are sampled. Thus, even though peak spawning periods for blue and white marlin are known to occur from May to June, there are significant issues related to positive identification of larvae that must be overcome to verify spawning locations. Research off Punta Cana, Dominican Republic, is one of the few instances on record where spawning by blue and white marlin was confirmed through simultaneous collections of both larvae and tracking of spawning adults using pop-up satellite tags (Prince et al., 2005).

Collaborative studies conducted by NMFS and University of Miami scientists using PSATs while simultaneously conducting adult and larval sampling off the Dominican Republic in the spring of 2003 have revealed important information concerning white and blue marlin spawning locations as well as horizontal and vertical movements. Co-occurrence of larval blue marlin and white marlin in samples suggest that the two species share a spawning location in the vicinity of Punta Cana, Dominican Republic. Adult white and blue marlin caught in the area appear to have similar vertical and horizontal movement patterns in terms of time at depth, time at temperature, average horizontal displacement per day, net horizontal displacement, and directional dispersion (compass heading).

Displacements of seven white marlins tagged with PSATs ranged from 31.7 to 267.7 nm (58.7 to 495.8 km), while displacement of one blue marlin was 219.3 nm (406.2 km). In general, all marlin spent a high proportion of the monitoring time in the upper 25 m (82 ft) and at temperatures at or above 28°C (82°F). Minimum and maximum depth and temperatures monitored show that on most days marlin visited depths of 100 m (330 ft) or more, but generally stayed at these depths less that 10 percent of the time. Minimum temperatures ranged from 16.8° to 20.6°C (62.2° to 69°F), while maximum temperatures ranged from 28.2° to 30.0°C (82.7° to 86°F). Additional research in other areas of the Gulf of Mexico and U.S. Atlantic coast would help improve understanding and delineation of billfish EFH (Prince et al., 2005).

The characterization of adult movements and larval distribution in a potentially important spawning area is paramount for establishing improved management and rebuilding strategies for depressed Atlantic billfish stocks. However, more information on the distribution of reproduction and nursery areas and on adult movement patterns is needed to help managers make more informed decisions regarding conservation of the resource. Scientists at VIMS have been involved with electronic tagging of blue and white marlin since 1999, some of which has been conducted in conjunction with the NOAA SEFSC. More recently, VIMS has deployed over 60 PSAT on white marlin during the past three years from both recreational sport boats and a commercial pelagic longline vessel to determine post-release survival (Prince et al., 2005). In addition to this work, VIMS is also in the process of updating information regarding habitat preferences and vertical movements of white marlin using environmental data obtained from the PSAT work as well as other environmental data. Most of the work at VIMS, however, remains focused on the interactions of billfish with the various fisheries.

There are a few considerations and limitations of these data that reviewers should keep in mind as they look at EFH determinations (E. Prince pers. comm.). Inaccurate EFH maps for billfish can be created because of boat side misidentification of billfish, sexual dimorphism, and criteria used in defining groups can result in both under and overestimates and ultimately impact the accuracy of the maps. The CTS is the main source of data for most of the billfish EFH maps and it obtains size information of tagged, released, and recovered fish from constituents based mostly on boatside estimates of fish size. This approach introduces a significant amount of error.

In addition, most size estimates are made when the fish is underwater and the reflective index biases these estimates upwards by as much as 30 percent (E. Prince, pers. comm.). Billfish are sexually dimorphic (size difference between sexes), with this being most severe for blue marlin. The maps provided in this amendment do not include a consideration of sexually dimorphic differences in size and thus the characterization of juvenile size limits on the maps may be quite different for male and female marlin. The tagging data only infrequently have recoveries that include gender, so separating the maps into males and females would not likely be practical, even though it would probably be more accurate (E. Prince, pers. comm.). Furthermore, the accuracy of the maps for defining juvenile marlin based on size could vary depending on the criteria used in this definition.

Data from the CTS, which account for a significant portion of the overall data points for billfish, were historically recorded only to the nearest degree, and did not include minutes or seconds. As a result, reviewers will notice that certain data points that reflect a high number of observations are lined up along major lines of latitude or longitude, both in the Gulf of Mexico and the Atlantic coast. This may be an artifact resulting from the way in which tagging locations were recorded rather than the true points of highest observed occurrence. Depending on reviewer comments received on this aspect of the data, NMFS may consider removing these data points during future considerations of EFH boundaries. Therefore, as a result of technical reviewer comments, several changes to EFH boundaries may be considered in the future. These include, but are not limited to, potential modifications of EFH boundaries for blue and white marlin for the reasons stated above (E. Prince, pers. comm.).

Sharks

Significant progress has been made in recent years in identifying habitat requirements and EFH for sharks. The proximity of nursery and pupping grounds to coastal areas has provided research opportunities that do not exist for other HMS that spawn much farther from shore. Sampling has increased in a number of different locations under the auspices of several different programs (Cooperative Atlantic States Shark Pupping and Nursery Survey (COASTSPAN), Cooperative Gulf of Mexico States Shark Pupping and Nursery Survey (GULFSPAN), and others). Considerable research has been devoted to determining the size ranges of the different shark life stages (neonate, juvenile, and adult). The size ranges for each species' lifestage used in this review as well as size ranges used in the 1999 FMP are presented in Table B.1, Appendix B. The table reflects new information and updates to the 1999 FMP size ranges. Based on these size ranges, the distribution data have been mapped for each species and life stage.

The 1999 FMP highlighted the importance of coastal nursery and pupping areas in maintaining viable shark populations. It also identified continued delineation of shark nurseries as a research priority. As a result, several studies and cooperative research projects aimed at improving NMFS' understanding of EFH and shark reproductive habitat requirements have been undertaken since the 1999 HMS FMP.
In 2002, the COASTPAN project initiated a synthesis document of information on shark nursery grounds along the U.S. Atlantic east coast and the Gulf of Mexico. Researchers from universities and state and Federal agencies in twelve different states from Massachusetts to Texas contributed information to the preliminary report (McCandless et al., 2002; McCandless et. al., 2005). This information was included in updates to EFH for several shark species in Amendment 1 to the FMP, and is being incorporated into the data for the current review. Results for the 2003 sampling year were compiled and synthesized, and the final report is currently under review. Participants in the 2003 COASTSPAN survey included the North Carolina Division of Marine Fisheries, the South Carolina Department of Natural Resources, Coastal Carolina University, the University of Georgia's Marine Extension Service and the University of Florida's Program for Shark Research. Researchers from the National Marine Fisheries Service's Apex Predators Program and the University of Rhode Island conducted the survey in Delaware Bay. A total of 3,698 sharks were sampled in the 2003 COASTSPAN survey. Juvenile sharks sampled, tagged and released during the survey were the Atlantic sharpnose, blacknose, blacktip, bonnethead, bull, dusky, finetooth, nurse, sandbar, sand tiger, scalloped hammerhead, silky, spinner, and tiger sharks, and also the smooth and spiny dogfish. Environmental parameters for each sampling location were also measured to indicate habitat preferences. There were a number of tag recaptures returned by fishery biologists and commercial and recreational fisherman in 2003 from sharks that were tagged by COASTSPAN cooperators in previous years.
A final synthesis document entitled "Shark Nursery Grounds of the Gulf of Mexico and the East Coast Waters of the United States" is currently under review for publication by the American Fisheries Society (AFS). It is a compilation of 20 individual papers documenting shark distributions in coastal habitats similar to the project described above, but expanded to include several new studies. This document provides valuable information for the possible modification or inclusion of additional shark EFH.

In 2003, NMFS initiated the GULFSPAN Survey to expand upon the Atlantic COASTSPAN Survey. States involved in the program during 2004, the second year of the program, include Florida, Mississippi, Alabama, and Louisiana. Sharks sampled, tagged, and released during the surveys included the Atlantic sharpnose, blacknose, blacktip, bonnethead, bull, finetooth, great hammerhead, sandbar, scalloped hammerhead, and spinner sharks. In addition, environmental parameters were measured qualitatively. The most abundant sharks included the Atlantic sharpnose, blacktip, and bull sharks. Results of this study are under review in the AFS synthesis document as well.

In Florida waters, most species captured were juveniles and young-of-the-year. Among sharks for all areas combined, the Atlantic sharpnose shark, a member of the small coastal shark (SCS) management group, was the most abundant shark captured, while the blacktip shark was the most abundant species captured in the LCS management group. The bonnethead shark was the second most abundant species captured in the SCS group and overall was the third most encountered species. The remaining species commonly captured in decreasing order of abundance were the finetooth, spinner, scalloped hammerhead, blacknose, and sandbar sharks. Other species infrequently caught were bull shark, great hammerhead shark, and the Florida smoothhound.

In Mississippi and Alabama waters, 75 percent of the sharks captured were immature. The blacktip shark was the most abundant species caught, followed by the Atlantic sharpnose, finetooth, and bull sharks. In Louisiana in the 2004 sampling season, most species captured were juveniles. The blacktip shark was the most abundant species caught, followed by the bull shark. A single adult specimen of the finetooth shark in addition to young-of-the-year Atlantic sharpnose shark was also collected in 2004. New information on habitat preferences is also emerging from this study. Juvenile bonnethead sharks appear to prefer habitat dominated by seagrass (in northwest Florida) or mangroves (Louisiana), although these areas have not yet been identified as EFH. In areas where neither of these habitat types is available, juvenile bonnetheads are in very low numbers or absent (i.e. Mississippi Sound). Adult bonnethead sharks, however, are found in diverse habitats ranging from areas with a mud or sand bottom to areas dominated by seagrass. Evidence indicates bull sharks are found among the most diverse environmental conditions with salinities ranging from 15 ppt (in Louisiana and Mississippi) to 33 ppt (in northwest Florida), and over all habitat types. Within the Gulf of Mexico, most juvenile sandbar sharks are still predominately caught in the northwest portion while blacktip, finetooth, and Atlantic sharpnose sharks are found throughout all areas. Although bull sharks can be found over a variety of habitats, the areas of highest abundance are those adjacent to freshwater inflow.

Obtaining information regarding trophic relationships and feeding habits of sharks, also critical to understanding essential fish habitat, is another goal of the GULFSPAN program. A quantitative examination of feeding ecology from different areas can assist in understanding how juvenile sharks use nursery habitats, and which habitats are more valuable as nursery areas than others.

Mote Marine Laboratory’s CSR program is focusing on identifying and understanding shark nursery areas of the U.S. Gulf of Mexico and southeast Atlantic coasts. Through tagging studies, this program aims to characterize these nursery areas, obtain estimates of juvenile shark relative abundance, distribution, and growth rates, and reveal the movement patterns of these sharks. As of fall 2004, the CSR has collected data on 20,732 sharks of 16 species that utilize these coastal waters as pupping and nursery areas. More than half of the captured sharks (12,241) comprise neonate, young-of-the-year (YOY) or older juvenile sharks. The studies found that most pupping activity in the region occurs in the late spring and early summer, and the neonate and YOY animals inhabit the primary nurseries throughout the summer and into the fall. Typically, declining water temperatures in the fall are associated with the southward movement of sharks from these natal waters to warmer and in some cases offshore, winter nurseries. Tag returns of Year-1 sharks have demonstrated travel distances to winter nursery areas of at least 500 km (311 mi). Tag return data have further demonstrated annual cycles of philopatric behavior whereby juveniles of both large and small coastal species migrate back to their natal nurseries in spring and summer (Hueter and Tyminski, in review).

In the 1999 HMS FMP, the smallest size class of sharks was described as “neonates and early juveniles.” This definition has been modified to include primarily neonates and only small young-of-the-year sharks in order to better define and identify nursery areas. The total length cutoff for this size class is determined as the maximum embryo size in term females plus 10 percent. This criteria was used because it helps to eliminate some of the small one-year-old sharks that fall within the young-of the-year size range, making it easier to identify primary nursery areas (where pupping occurs and young-of-the-year are present). These criteria can also be more easily applied to other species given the lack of published data on growth rates for many species, especially during the first year. This modification should also better represent the habitat shift between primary nursery areas and secondary nursery areas (occupied by age 1+ sharks), although many species do overlap habitat use between these two size classes.

The middle size class designated in the 1999 HMS FMP, “late juveniles and subadults,” has been renamed “juveniles”. This size class includes all immature sharks from young juveniles to older or late juveniles. Some overlap between the “neonate and early juveniles” and the “adult” EFH areas may occur, depending on the species, due to the return to primary nursery areas by many juveniles, age 1+, and the developing conformity to adult migration patterns by late juveniles. As in the 1999 HMS FMP, the largest size class, “adults,” still consists of mature sharks based on the size at first maturity for females of the species. Changes to the size range of the adult size class for some species have been made based on new information on the size at first maturity for females of those particular species.

As a result of technical reviewer comments of the 2006 Consolidated Highly Migratory Species FMP, several changes to EFH boundaries may be considered in the future. These include, but are not limited to, potential modification of EFH boundaries for basking, hammerhead, white, bull, Caribbean reef, lemon, spinner, tiger, Atlantic sharpnose, blacknose, longfin mako, shortfin mako, oceanic whitetip, and thresher sharks (J. Castro and J. Carlson, pers. comm.). In summary, based on the preliminary examination of new information acquired since the original EFH identifications in 1999, and on comments from technical reviewers, modifications to some of the existing EFH descriptions and boundaries may be warranted. Any proposed modifications to existing boundaries, as well as consideration of any new HAPC areas, would be by the addressed by the NMFS’ Highly Migratory Species Division in a subsequent document to the 2006 Consolidated HMS FMP.

7.3 Essential Fish Habitat and Environmental Protection Policy

In recognizing that managed species are dependent on the quantity and quality of their essential habitats, it is the policy of the SAFMC to protect, restore, and develop habitats upon which species fisheries depend; to increase the extent of their distribution and abundance; and to improve their productive capacity for the benefit of present and future generations. For purposes of this policy, "habitat" is defined as the physical, chemical, and biological parameters that are necessary for continued productivity of the species that is being managed. The objectives of the SAFMC policy will be accomplished through the recommendation of no net loss or significant environmental degradation of existing habitat. A long-term objective is to support and promote a net-gain of fisheries habitat through the restoration and rehabilitation of the productive capacity of habitats that have been degraded, and the creation and development of productive habitats where increased fishery production is probable. The SAFMC will pursue these goals at state, Federal, and local levels. The Council shall assume an aggressive role in the protection and enhancement of habitats important to species, and shall actively enter Federal, decision-making processes where proposed actions may otherwise compromise the productivity of fishery resources of concern to the Council.

7.4 Essential Fish Habitat Policies and Policy Statements

7.4.1 Policy Statements of Essential Fish Habitat Types

7.4.1.1 Policy for the Protection and Enhancement of Marine Submerged Aquatic Vegetation (SAV) Habitat

The South Atlantic Fishery Management Council (SAFMC) and the Habitat and Environmental Protection Advisory Panel has considered the issue of the decline of Marine Submerged Aquatic Vegetation SAV (or seagrass) habitat in Florida and North Carolina as it relates to Council habitat policy. Subsequently, the Council's Habitat Committee requested that the Habitat Advisory Panel develop the following policy statement to support Council efforts to protect and enhance habitat for managed species.

Description and Function

In the South Atlantic region, SAV is found primarily in the states of Florida and North Carolina where environmental conditions are ideal for the propagation of seagrasses. The distribution of SAV habitat is indicative of its importance to economically important fisheries: in North Carolina, total SAV coverage is estimated to be 200,000 acres; in Florida, the total SAV coverage is estimated to be 2.9 million acres. SAV serves several valuable ecological functions in the marine systems where it occurs. Food and shelter afforded by SAV result in a complex and dynamic system that provides a primary nursery habitat for various organisms that is important both to the overall system ecology as well as to commercial and recreationally important fisheries. SAV habitat is valuable both ecologically as well as economically; as feeding, breeding, and nursery ground for numerous estuarine species, SAV provides for rich ecosystem diversity. Further, a number of fish and shellfish species, around which is built several vigorous commercial and recreational fisheries, rely on SAV habitat for a least a portion of their life cycles. For more detailed discussion, please see Appendix 1 below.

Status
SAV habitat is currently threatened by the cumulative effects of overpopulation and consequent commercial development and recreation in the coastal zone. The major anthropogenic threats to SAV habitat include:

1. mechanical damage due to:
    a. propeller damage from boats,
    b. bottom-disturbing fish harvesting techniques,
    c. dredging and filling;

2. biological degradation due to:
    a. water quality deterioration by modification of temperature, salinity, and light attenuation regimes;
    b. addition of organic and inorganic chemicals.

SAV habitat in both Florida and North Carolina has experienced declines from both natural and anthropogenic causes. However, conservation measures taken by state and federal agencies have produced positive results. The national Marine Fisheries Service has produced maps of SAV habitat in the Albemarle-Pamlico Sound region of North Carolina to help stem the loss of this critical habitat. The threats to this habitat and the potential for successful conservation measures highlight the need to address the decline of SAV. Therefore, the South Atlantic Council recommends immediate and direct action be taken to stem the loss of this essential habitat. For more detailed discussion, please see Appendix 2 below.

Management
Conservation of existing SAV habitat is critical to the maintenance of the living resources that depend on these systems. A number of federal and state laws and regulations apply to modifications, either direct or indirect, to SAV habitat. However, to date the state and federal regulatory process has accomplished little to slow the decline of SAV habitat. Furthermore, mitigative measures to restore or enhance impacted SAV have met with little success. These habitats cannot be readily restored; the South Atlantic Council is not aware of any seagrass restoration project that has ever prevented a net loss of SAV habitat. It has been difficult to implement effective resource management initiatives to preserve existing seagrass habitat resources due to the lack of adequate documentation and specific cause/effect relationships. (for more detailed discussion, please see Appendix 3 below).

Because restoration/enhancement efforts have not met with success, the South Atlantic Council considers it imperative to take a directed and purposeful action to protect remaining SAV habitat. The South Atlantic Council strongly recommends that a comprehensive strategy to address the disturbing decline in SAV habitat in the South Atlantic region. Furthermore, as a stepping stone to such a long-term protection strategy, the South Atlantic Council recommends that a reliable status and trend survey be adopted to verify the scale of local declines of SAV.

The South Atlantic Council will address the decline of SAV, and consider establishing specific plans for revitalizing the SAV resources of the South Atlantic region. This may be achieved by the following integrated triad of efforts:

Planning

- The Council promotes regional planning which treats SAV as an integral part of an ecological system.

- The Council supports comprehensive planning initiatives as well as interagency coordination and planning on SAV matters.

- The Council recommends that the Habitat Advisory Panel members actively seek to involve the Council in the review of projects which will impact, either directly or indirectly, SAV habitat resources.

Monitoring and Research

Periodic surveys of SAV in the region are required to determine the progress toward the goal of a net resource gain.

The Council supports efforts to:

- standardize mapping protocols,
- develop a Geographic Information System databases for essential habitat including seagrass, and
- research and document causes and effects of SAV decline including the cumulative impacts of shoreline development.

Education and Enforcement

- The Council supports education programs designed to heighten the public's awareness of the importance of SAV. An informed public will provide a firm foundation of support for protection and restoration efforts.

- Existing regulations and enforcement need to be reviewed for their effectiveness.

- Coordination with state resource and regulatory agencies should be supported to assure that existing regulations are being enforced.

SAFMC SAV Policy Statement- Appendix 1

Description and function

Worldwide, Submerged Aquatic Vegetation (SAV) constitutes one of the most conspicuous and common shallow-water habitat types. These angiosperms have successfully colonized standing and flowing fresh, brackish, and marine waters in all climatic zones, and most are rooted in the sediment. Marine SAV beds occur in the low intertidal and subtidal zones and may exhibit a wide range of habitat forms, from extensive collections of isolated patches to unbroken continuous beds. The bed is defined by the presence of either aboveground vegetation, its associated root and rhizome system (with living meristem), or the presence of a seed bank in the sediments, as well as the sediment upon which the plant grows or in which the seed back resides. In the case of patch beds, the unvegetated sediment among the patches is considered seagrass habitat as well.

There are seven species of seagrass in Florida's shallow coastal areas: turtle grass (*Thalassia testudium*); manatee grass (*Syringodium filiforme*); shoal grass (*Halodule wrightii*); star grass (*Halophila engelmanni*); paddle grass (*Halophila decipiens*); and Johnson's seagrass (*Halophila johnsonii*) (Distribution maps in Appendix 4 SAFMC, 1998a). Recently, *H. johnsonii* has been proposed for listing by the National Marine Fisheries Service as an endangered plant species. Areas of seagrass concentration along Florida's east coast are Mosquito Lagoon, Banana River, Indian River Lagoon, Lake Worth and Biscayne Bay. Florida Bay, located between the Florida Keys and the mainland, also has an abundance of seagrasses, but is currently experiencing an unprecedented decline in SAV distribution.

The three dominant species found in North Carolina are shoalgrass (*Halodule wrightii*), eelgrass (*Zostera marina*), and widgeongrass (*Ruppia maritima*). Shoalgrass, a subtropical species has its northernmost distribution at Oregon Inlet, North Carolina. Eelgrass, a temperate species, has its southernmost distribution in North Carolina. Areas of seagrass concentration in North Carolina are southern and eastern Pamlico Sound, Core Sound, Back Sound, Bogue Sound and the numerous small southern sounds located behind the beaches in Onslow, Pender, Brunswick, and New Hanover Counties (See distribution maps in Appendix 4 SAFMC, 1998).

Seagrasses serve several valuable ecological functions in the marine estuarine systems where they occur. Food and shelter afforded by the SAV result in a complex and dynamic system that provides a primary nursery habitat for various organisms that are important both ecologically and to commercial and recreational fisheries. Organic matter produced by these seagrasses is transferred to secondary consumers through three pathways: herbivores that consume living plant matter; detritivores that exploit dead matter; and microorganisms that use seagrass-derived particulate and dissolved organic compounds. The living leaves of these submerged plants also provide a substrate for the attachment of detritus and epiphytic organisms, including bacteria, fungi, meiofauna, micro- and marcroalgae, macroinvertebrates. Within the seagrass system, phytoplankton also are present in the water column, and macroalgae and microalgae are associated with the sediment. No less important is the protection afforded by the variety of living spaces in the tangled leaf canopy of the grass bed itself. In addition to biological benefits, the SAVs also cycle nutrients and heavy metals in the water and sediments, and dissipate wave energy (which reduces shoreline erosion and sediment resuspension).

There are several types of association fish may have with the SAVs. Resident species typically breed and carry out much of their life history within the meadow (e.g., gobiids and syngnathids). Seasonal residents typically breed elsewhere, but predictably utilize the SAV during a portion of their life cycle, most often as a juvenile nursery ground (e.g., sparids and lutjanids). Transient species can be categorized as those that feed or otherwise utilize the SAV only for a portion of their daily activity, but in a systematic or predictable manner (e.g., haemulids).

In Florida many economically important species utilize SAV beds as nursery and/or spawning habitat. Among these are spotted seatrout (*Cynoscion nebulosus*), grunts (Haemulids), snook (*Centropomus* sp.), bonefish (*Albula vulpes*), tarpon (*Megalops atlanticus*) and several species of snapper (Lutjanids) and grouper (Serranids). Densities of invertebrate organisms are many times greater in seagrass beds than in bare sand habitat. Penaeid shrimp, spiny lobster (*Panulirus argus*), and bay scallops (*Argopecten irradians*) are also dependent on seagrass beds.

In North Carolina 40 species of fish and invertebrates have been captured on seagrass beds. Larval and juvenile fish and shellfish including gray trout (*Cynoscion regalis*), red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), mullet (*Mugil cephalus*), spot (*Leiostomus xanthurus*), pinfish (*Orthopristis chrysoptera*), gag (*Mycteroperca microlepis*), white grunt (*Haemulon plumieri*), silver perch (*Bairdiella chrysoura*), summer flounder (*Paralichthys dentatus*), southern flounder (*P. lethostigma*), blue crabs (*Callinectes sapidus*), hard shell clams (*Mercenaria mercenaria*), and bay scallops (*Argopecten irradians*) utilize the SAV beds as nursery areas. They are the sole nursery grounds for bay scallops in North Carolina. SAV meadows are also frequented by adult spot, spotted seatrout, bluefish (*Pomatomus saltatrix*), menhaden (*Brevoortia tyrannus*), summer and southern flounder, pink and brown shrimp, hard shell clams, and blue crabs. Offshore reef fishes including black sea bass (*Centropristis striata*), gag (*Mycteroperca microlepis*), gray snapper (*Lutjanus griseus*), lane snapper (*Lutjanus synagris*), mutton snapper (*Lutjanus annalis*), and spottail pinfish (*Diplodus holbrooki*). Ospreys, egrets, herons, gulls and terns feed on fauna in SAV beds, while swans, geese, and ducks feed directly on the grass itself. Green sea turtles (*Chelonia mydas*) also utilize seagrass beds, and juveniles may feed directly on the seagrasses.

SAFMC SAV Policy Statement- Appendix 2

Status

The SAV habitat represents a valuable natural resource which is now threatened by overpopulation in coastal areas. The major anthropogenic activities that impact seagrass habitats are: 1) dredging and filling, 2) certain fish harvesting techniques and recreational vehicles, 3) degradation of water quality by modification of normal temperature, salinity, and light regimes, and 4) addition of organic and inorganic chemicals. Although not caused by man, disease ("wasting disease" of eelgrass) has historically been a factor. Direct causes such as dredging and filling, impacts of bottom disturbing fishing gear, and impacts of propellers and boat wakes are easily observed, and can be controlled by wise management of our seagrass resources (See Appendix 3 below). Indirect losses are more subtle and difficult to assess. These losses center around changes in light availability to the plants by changes in turbidity and water color. Other indirect causes of seagrass loss may be ascribed to changing hydrology which may in turn affect salinity levels and circulation. Reduction in flushing can cause an increase in salinity and the ambient temperature of a water body, stressing the plants. Increase in flushing can mean decreased salinity and increased turbidity and near-bottom mechanical stresses which damage or uproot plants.

Increased turbidity and decreasing water transparency are most often recognized as the cause of decreased seagrass growth and altered distribution of the habitats. Turbidity may result from upland runoff, either as suspended sediment or dissolved nutrients. Reduced transparency due to color is affected by freshwater discharge. The introduction of additional nutrients from terrigenous sources often leads to plankton blooms and increased epiphytization of the plants, further reducing light to the plants. Groundwater enriched by septic systems also may infiltrate the sediments, water column, and near-shore seagrass beds with the same effect. Lowered dissolved oxygen is detrimental to invertebrate and vertebrate grazers. Loss of these grazers results in overgrowth by epiphytes.

Large areas of Florida where seagrasses were abundant have now lost these beds from both natural and man-induced causes (this is not well documented on a large scale except in the case of Tampa Bay). One of these depleted areas is Lake Worth in Palm Beach County. Here, dredge and fill activities, sewage disposal and stormwater runoff have almost eliminated this resource. North Biscayne Bay lost most of its seagrasses from urbanization. The Indian River Lagoon has lost many seagrass beds from stormwater runoff has caused a decrease in water transparency and reduced light penetration. Many seagrass beds in Florida have been scarred from boat propellers disrupting the physical integrity of the beds. Vessel registrations, both commercial and recreational, have tripled from 1970-71 (235, 293) to 1992-93 (715,516). More people engaged in marine activities having an effect on the limited resources of fisheries and benthic communities, Florida's assessment of dredging/propeller scar damage indicates that Dade, Lee, Monroe, and Pinellas Counties have the most heavily damaged seagrass beds. Now Florida Bay, which is rather remote from human population concentrations, is experiencing a die-off of seagrasses, the cause of which has not yet been isolated. Cascading effects of die-offs cause a release of nutrients resulting in algal blooms which, in turn, adversely affect other seagrass areas, and appear to be preventing recolonization and natural succession in the bay. It appears that Monroe County's commercial fish and shellfish resources, with a dockside landing value of $50 million per year, is in serious jeopardy.

In North Carolina total SAV coverage is estimated at 200,000 acres. Compared to the state's brackish water SAV community, the marine SAVs appear relatively stable. The drought and increased water clarity during the summer of 1986 apparently caused an increase in SAV abundance in southeastern Pamlico Sound and a concomitant increase in bay scallop densities. Evidence is emerging, however, that characteristics of "wasting disease" are showing up in some of the eelgrass populations in southern Core Sound, Back Sound, and Bogue Sound. The number of permits requested for development activities that potentially impact SAV populations is increasing. The combined impacts of a number of small, seemingly isolated activities are cumulative and can lead to the collapse of large seagrass biosystems. Also increasing is evidence of the secondary removal of seagrasses. Clam-kicking (the harvest of hard clams utilizing powerful propeller wash to dislodge the clams from the sediment) is contentious issue within the state of North Carolina. The scientific community is convinced that mechanical harvesting of clams damages SAV communities. The scallop fishery also could be harmed by harvest-related damage to eelgrass meadows.

SAFMC SAV Policy Statement- Appendix 3

Management

Conservation of existing SAV habitat is critical to the maintenance of the living resources that depend on these systems. A number of federal and state laws require permits for modification and/or development in SAV. These include Section 10 of the Rivers and Harbors Act (1899), Section 404 of the Clean Water Act (1977), and the states' coastal area management programs. Section 404 prohibits deposition of dredged or fill material in waters of the United States without a permit from the U.S. Army Corps of Engineers. The Fish and Wildlife Coordination Act gives federal and state resource agencies the authority to review and comment on permits, while the National Environmental Policy Act requires the development and review of Environmental Impact Statements. The Magnuson Fisheries Conservation and Management Act has been amended to require that each fishery management plan include a habitat section. The Council's habitat subcommittee may comment on permit requests submitted to the Corps of Engineers when the proposed activity relates to habitat essential to managed species. State and federal regulatory processes have accomplished little to slow the decline of SAV habitat. Many of the impacts cannot be easily controlled by the regulations as enforced. For example, water quality standards are written so as to allow a specified deviation from background concentration, in this manner standards allow a certain amount of degradation. An example of this is Florida's class III water transparency standard, which defines the compensation depth to be where 1% of the incident light remains. The compensation depth for seagrass is in excess of 10% and for some species is between 15 and 20%. The standard allows a deviation of 10% in the compensation depth which translates into 0.9% incident light or an order of magnitude less than what the plants require. Mitigative measures to restore or enhance impacted areas have met with little success. SAV habitats cannot be readily restored; in fact, the South Atlantic Council is not aware of any seagrass restoration project that has ever avoided a net loss of seagrass habitat. It has been difficult to implement effective resource management initiatives to preserve seagrass habitat due to the lack of documentation on specific cause/effect relationships. Even though studies have identified certain cause/effect relationships in the destruction of these areas, lack of long-term, ecosystem-scale studies precludes an accurate scientific evaluation of the long-term deterioration of seagrasses. Some of the approaches to controlling propeller scar damage to seagrass beds include: education, improved channel marking restricted access zones, (complete closure to combustion engines, pole or troll areas), and improved enforcement. The South Atlantic Council sees the need for monitoring of seagrass restoration and mitigation not only to determine success from plant standpoint but also for recovery of faunal populations and functional attributes of the essential habitat type. The South Atlantic Council also encourages long-term trend analysis monitoring of distribution and abundance using appropriate protocols and Geographic Information System approaches.

SAFMC SAV Policy Statement- Appendix 4

(SAV Distribution Maps in SAFMC 1995 and Revised in Appendix C of the Habitat Plan)

7.4.2 Policy Statements on Non-fishing Activities Affecting Habitat

7.4.2.1 Policies for the Protection and Restoration of EFH from Beach Dredging and Filling and Large-Scale Coastal Engineering

Policy Context

This document establishes the policies of the South Atlantic Fishery Management Council (SAFMC) regarding protection of the essential fish habitats (EFH) and habitat areas of particular concern (EFH-HAPCs) impacted by beach dredge and fill activities, and related large-scale coastal engineering projects. The policies are designed to be consistent with the overall habitat protection policies of the SAFMC as formulated and adopted in the Habitat Plan (SAFMC, 1998a) and the Comprehensive EFH Amendment (SAFMC, 1998b).

The findings presented below assess the threats to EFH potentially posed by activities related to the large-scale dredging and disposal of sediments in the coastal ocean and adjacent habitats, and the processes whereby those resources are placed at risk. The policies established in this document are designed to avoid, minimize and offset damage caused by these activities, in accordance with the general habitat policies of the SAFMC as mandated by law.

EFH At Risk from Beach Dredge and Fill Activities

The SAFMC finds:

1. In general, the array of large-scale and long-term beach dredging projects and related disposal activities currently being considered for the United States southeast together constitute a real and significant threat to EFH under the jurisdiction of the SAFMC.

2. The cumulative effects of these projects have not been adequately assessed, including impacts on public trust marine and estuarine resources, use of public trust beaches, public access, state and federally protected species, state critical habitat, SAFMC-designated EFH and EFH-HAPCs.

3. Individual beach dredge and fill projects and related large-scale coastal engineering activities rarely provide adequate impact assessments or consideration of potential damage to fishery resources under state and federal management. Historically, emphasis has been placed on the logistics of dredging and economics, with environmental considerations dominated by compliance with the Endangered Species Act for sea turtles, piping plovers and other listed organisms. There has been little or

no consideration of hundreds of other species affected, many with direct fishery value.

4. Opportunities to avoid or minimize impacts of beach dredge and fill activities on fishery resources, and offsets for unavoidable impacts have rarely been proposed or implemented. Monitoring is rarely adequate to develop statistically appropriate impact evaluations.

5. Large-scale beach dredge and fill activities have the potential to impact a variety of habitats across the shelf, including:

    a. waters and benthic habitats near the dredging sites
    b. waters between dredging and filling sites
    c. waters and benthic habitats in or near the fill sites, and
    d. waters and benthic habitats potentially affected as sediments move subsequent to deposition in fill areas.

6. Certain nearshore habitats are particularly important to the long-term viability of commercial and recreational fisheries under SAFMC management, and potentially threatened by large-scale, long-term or frequent disturbance by dredging and filling:

    a. the swash and surf zones and beach-associated bars
    b. underwater soft-sediment topographic features
    c. onshore and offshore coral reefs, hardbottom and worm reefs
    d. inlets

7. Large sections of South Atlantic waters potentially affected by these projects, both individually and collectively, have been identified as EFH or EFH-HAPC by the SAFMC, as well as the Mid-Atlantic Fishery Management Council (MAFMC) in the case of North Carolina. Potentially Affected species and their EFH under federal management include (SAFMC, 1998b):

    a. summer flounder (various nearshore waters, including the surf zone and inlets; certain offshore waters)
    b. bluefish (various nearshore waters, including the surf zone and inlets)
    c. red drum (ocean high-salinity surf zones and unconsolidated bottoms nearshore waters)
    d. many snapper and grouper species (live hardbottom from shore to 600 feet, and – for estuarine-dependent species [e.g., gag grouper and gray snapper] – unconsolidated bottoms and live hardbottoms to the 100 foot contour).
    e. black sea bass (various nearshore waters, including unconsolidated bottom and live hardbottom to 100 feet, and hardbottoms to 600 feet)
    f. penaeid shrimp (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas, including the surf zone and inlets)

g. coastal migratory pelagics [e.g., king mackerel, Spanish mackerel] (sandy shoals of capes and bars, barrier island ocean-side waters from the surf zone to the shelf break inshore of the Gulf Stream; all coastal inlets)
h. corals of various types (hard substrates and muddy, silt bottoms from the subtidal to the shelf break)
i. areas identified as EFH for Highly Migratory Species (HMS) managed by the Secretary of Commerce (e.g., sharks: inlets and nearshore waters, including pupping and nursery grounds)

In addition, hundreds of species of crustaceans, mollusks, and annelids that are not directly managed, but form the critical prey base for most managed species, are killed or directly affected by large dredge and fill projects.

8. Beach dredge and fill projects also potentially threaten important habitats for anadromous species under federal, interstate and state management (in particular, inlets and offshore overwintering grounds), as well as essential overwintering grounds and other critical habitats for weakfish and other species managed by the Atlantic States Marine Fisheries Commission (ASMFC) and the states. The SAFMC also identified essential habitats of anadromous and catadromous species in the region (inlets and nearshore waters).

9. Many of the habitats potentially affected by these projects have been identified as EFH-HAPCs by the SAFMC. The specific fishery management plan is provided in parentheses:

    a. all nearshore hardbottom areas (SAFMC, snapper grouper).
    b. all coastal inlets (SAFMC, penaeid shrimps, red drum, and snapper grouper).
    c. near-shore spawning sites (SAFMC, penaeid shrimps, and red drum).
    d. benthic *Sargassum* (SAFMC, snapper grouper).
    e. from shore to the ends of the sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras, North Carolina; Hurl Rocks, South Carolina; *Phragmatopoma* (worm reefs) reefs off the central coast of Florida and nearshore hardbottom south of Cape Canaveral (SAFMC, coastal migratory pelagics).
    f. Atlantic coast estuaries with high numbers of Spanish mackerel and cobia from ELMR, to include Bogue Sound, New River, North Carolina; Broad River, South Carolina (SAFMC, coastal migratory pelagics).
    g. Florida Bay, Biscayne Bay, Card Sound, and coral hardbottom habitat from Jupiter Inlet through the Dry Tortugas, Florida (SAFMC, Spiny Lobster)
    h. Hurl Rocks (South Carolina), The *Phragmatopoma* (worm reefs) off central east coast of Florida, nearshore (0-4 meters; 0-12 feet) hardbottom off the east coast of Florida from Cape Canaveral to Broward County; offshore (5-30 meters; 15-90 feet) hardbottom off the east coast of Florida from Palm Beach County to Fowey Rocks; Biscayne Bay, Florida; Biscayne National Park, Florida; and the Florida Keys National Marine Sanctuary (SAFMC, Coral, Coral Reefs and Live Hardbottom Habitat).

i. EFH-HAPCs designated for HMS species (e.g., sharks) in the South Atlantic region (NMFS, Highly Migratory Species).

10. Habitats likely to be affected by beach dredge and fill projects include many recognized in state-level fishery management plans. Examples of these habitats include Critical Habitat Areas established by the North Carolina Marine Fisheries Commission, either in FMPs or in Coastal Habitat Protection Plans (CHAs).

11. Recent work by scientists in east Florida has documented important habitat values for nearshore, hardbottom habitats often buried by beach dredging projects, is used by over 500 species of fishes and invertebrates, including juveniles of many reef fishes. Equivalent scientific work is just beginning in other South Atlantic states, but life histories suggest that similar habitat use patterns will be found.

Threats to Marine and Estuarine Resources from Beach Dredge and Fill Activities and Related Large Coastal Engineering Projects

The SAFMC finds that beach dredge and fill activities and related large-scale coastal engineering projects (including inlet alteration projects) and disposal of material for navigational maintenance, threaten or potentially threaten EFH through the following mechanisms:

1. Direct mortality and displacement of organisms at and near sediment dredging sites
2. Direct mortality and displacement of organisms at initial sediment fill sites
3. Elevated turbidity and deposition of fine sediments down-current from dredging sites
4. Alteration of seafloor topography and associated current and waves patterns and magnitudes at dredging areas
5. Alteration of seafloor sediment size-frequency distributions at dredging sites, with secondary effects on benthos at those sites
6. Elevated turbidity in and near initial fill sites, especially in the surf zone, and deposition of fine sediment down-current from initial fill sites (ASMFC, 2002)
7. Alteration of nearshore topography and current and wave patterns and magnitudes associated with fill
8. Movement of deposited sediment away from initial fill sites, especially onto hardbottoms
9. Alteration of large-scale sediment budgets, sediment movement patterns and feeding and other ecological relationships, including the potential for cascading disturbance effects
10. Alteration of large-scale movement patterns of water, with secondary effects on water quality and biota
11. Alteration of movement patterns and successful inlet passage for larvae, post-larvae, juveniles and adults of marine and estuarine organisms
12. Alteration of long-term shoreline migration patterns (inducing further ecological cascades with consequences that are difficult to predict)
13. Exacerbation of transport and/or biological uptake of toxicants and other pollutants released at either dredge or fill sites

In addition, the interactions between cumulative and direct (sub-lethal) effects among the above factors certainly triggers non-linear impacts that are completely unstudied.
SAFMC Policies for Beach Dredge and Fill Projects and Related Large Coastal Engineering Projects

The SAFMC establishes the following general policies related to large-scale beach dredge and fill and related projects, to clarify and augment the general policies already adopted in the Habitat Plan and Comprehensive Habitat Amendment (SAFMC 1998a; SAFMC 1998b):

1. Projects should avoid, minimize and where possible offset damage to EFH and EFH-HAPCs.

2. Projects requiring expanded EFH consultation should provide detailed analyses of possible impacts to each type of EFH, with careful and detailed analyses of possible impacts to EFH-HAPCs and state CHAs, including short and long-term, and population and ecosystem scale effects. Agencies with oversight authority should require expanded EFH consultation.

3. Projects requiring expanded EFH consultation should provide a full range of alternatives, along with assessments of the relative impacts of each on each type of EFH, HAPC and CHAs.

4. Projects should avoid impacts on EFH, HAPCs and CHAs that are shown to be avoidable through the alternatives analysis, and minimize impacts that are not.

5. Projects should include assessments of potential unavoidable damage to EFH and other marine resources, using conservative assumptions.

6. Projects should be conditioned on the avoidance of avoidable impacts, and should include compensatory mitigation for all reasonably predictable impacts to EFH, taking into account uncertainty about these effects. Mitigation should be local, up-front and in-kind, and should be adequately monitored, wherever possible.

7. Projects should include baseline and project-related monitoring adequate to document pre-project conditions and impacts of the projects on EFH.

8. All assessments should be based upon the best available science, and be appropriately conservative so follow and precautionary principles as developed for various federal and state policies.

9. All assessments should take into account the cumulative impacts associated with other beach dredge and fill projects in the region, and other large-scale coastal engineering projects that are geographically and ecologically related.

References

ASMFC, 2002. Beach Nourishment: A Review of the Biological and Physical Impacts ASMFC Habitat Management Series # 7 November 2002, Atlantic States Marine Fisheries Commission, 1444 Eye Street NW, Sixth Floor, Washington DC 20005. 179 pp.

Butler IV, M. J., J. H. Hunt, W. F. Herrnkind, M. J. Childress, R. Bertelsen, W. Sharp, T. Matthews, J. M. Field, and H. G. Marshall. 1995. Cascading disturbances in Florida Bay, U.S.A.: cyanobacteria blooms, sponge mortality, and implications for juvenile spiny lobsters Panulirus argus. Mar. Ecol. Prog. Ser. 129:119-125.

Dodge, R. E., R. C. Aller and J. Thomson. 1974. Coral growth related to resuspension of bottom sediments. Nature 247: 574-576.

Gilmore, R. G., Jr. 1977. Fishes of the Indian River Lagoon and adjacent waters, Florida. Bull. Fl. St. Mus. Bio. Sci. 22(3), 147 p.

Gilmore, R. G., Jr. 1992. Striped croaker, Bairdiella sanctaeluciae. pp. 218-222. In C. R. Gilbert, ed. Rare and endangered biota of Florida. II. Fishes. Univ. Press of Florida, Gainesville, FL, 242 p.

Greene, Karen. 2002. Beach nourishment: a review of the biological and physical impacts. Atlantic States Marine Fisheries Commission. Habitat Management Series #7, November 2002. 174 pp.

Hackney, C.T., M. Posey, S. Ross and A. Norris. 1996. A review and synthesis of data on surf zone fishes and invertebrates in the South Atlantic Bight and the potential impacts from beach renourishment. Report to the U.S. Army Corps of Engineers, Wilmington District.

Kirtley, D. W. and W. F. Tanner. 1968. Sabellariid worms: builders of a major reef type. J. Sed. Petrol. 38(1):73-78.

Lindeman, K. C. 1997. Comparative management of beach systems of Florida and the Antilles: applications using ecological assessment and decision support procedures. pp.134-164. In: G. Cambers, ed. Managing beach resources in the smaller Caribbean islands. UNESCO Coastal Region & Small Island Papers # 1, 269 p.

7.4.2.2 Policy Statement Concerning Dredging and Dredge Material Disposal Activities

Ocean Dredged Material Disposal Sites (ODMDS) and SAFMC Policies

The shortage of adequate upland disposal sites for dredged materials has forced dredging operations to look offshore for sites where dredged materials may be disposed. These Ocean Dredged Material Disposal Sites (ODMDSs) have been designated by the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (COE) as suitable sites for disposal of dredged materials associated with berthing and navigation channel maintenance activities. The South Atlantic Fishery Management Council (SAFMC; the Council) is moving to establish its presence in regulating disposal activities at these ODMDSs. Pursuant to the Magnuson Fishery Conservation and Management Act of 1976 (the Magnuson Act), the regional fishery management Councils are charged with management of living marine resources and their habitat within the 200 mile Exclusive Economic Zone (EEZ) of the United States. Insofar as dredging and disposal activities at the various ODMDSs can impact fishery resources or essential habitat under Council jurisdiction, the following policies address the Council's role in the designation, operation, maintenance, and enforcement of activities in the ODMDSs:

The Council acknowledges that living marine resources under its jurisdiction and their essential habitat may be impacted by the designation, operation, and maintenance of ODMDSs in the South Atlantic. The Council may review the activities of EPA, COE, the state Ports Authorities, private dredging contractors, and any other entity engaged in activities which impact, directly or indirectly, living marine resources within the EEZ. The Council may review plans and offer comments on the designation, maintenance, and enforcement of disposal activities at the ODMDSs.

ODMDSs should be designated or redesignated so as to avoid the loss of live or hard bottom habitat and minimize impacts to all living marine resources.

Notwithstanding the fluid nature of the marine environment, all impacts from the disposal activities should be contained within the designated perimeter of the ODMDSs.
The final designation of ODMDSs should be contingent upon the development of suitable management plans and a demonstrated ability to implement and enforce that plan. The Council encourages EPA to press for the implementation of such management plans for all designated ODMDSs.

All activities within the ODMDSs are required to be consistent with the approved management plan for the site.

The Council's Habitat and Environmental Protection Advisory Panel when requested by the Council will review such management plans and forward comment to the Council. The Council may review the plans and recommendations received from the advisory sub-panel and comment to the appropriate agency. All federal agencies and entities receiving a comment or recommendation from the Council will provide a detailed written response to the Council regarding the matter pursuant to 16 U.S.C. 1852 (i). All other agencies and entities receiving a comment or recommendation from the Council should provide a detailed written response to the Council regarding the matter, such as is required for federal agencies pursuant to 16 U.S.C. 1852 (i).

ODMDSs management plans should indicate appropriate users of the site. These plans should specify those entities/ agencies which may use the ODMDSs, such as port authorities, the U.S. Navy, the Corps of Engineers, etc. Other potential users of the ODMDSs should be acknowledged and the feasibility of their using the ODMDSs site should be assessed in the management plan.

Feasibility studies of dredge disposal options should acknowledge and incorporate ODMDSs in the larger analysis of dredge disposal sites within an entire basin or project. For example, Corps of Engineers analyses of existing and potential dredge disposal sites for harbor maintenance projects should incorporate the ODMDSs. as part of the overall analysis of dredge disposal sites.

The Council recognizes that EPA and other relevant agencies are involved in managing and/or regulating the disposal of all dredged material. The Council recognizes that disposal activities regulated under the Ocean Dumping Act and dredging/filling carried out under the Clean Water Act have similar impacts to living marine resources and their habitats. Therefore, the Council urges these agencies apply the same strict policies to disposal activities at the ODMDSs. These policies apply to activities including, but not limited to, the disposal of contaminated sediments and the disposal of large volumes of fine-grained sediments. The Council will encourage strict enforcement of these policies for disposal activities in the EEZ. Insofar as these activities are relevant to disposal activities in the EEZ, the Council will offer comments on the further development of policies regarding the disposal/ deposition of dredged materials.

The Ocean Dumping Act requires that contaminated materials not be placed in an approved ODMDS. Therefore, the Council encourages relevant agencies to address the problem of disposal of contaminated materials. Although the Ocean Dumping Act does not specifically address inshore disposal activities, the Council encourages EPA and other relevant agencies to evaluate sites for the suitability of disposal and containment of contaminated dredged material. The Council further encourages those agencies to draft management plans for the disposal of contaminated dredge materials. A consideration for total removal from the basin should also be considered should the material be contaminated to a level that it would have to be relocated away from the coastal zone.

Offshore and Nearshore Underwater Berm Creation

The use of underwater berms in the South Atlantic region has recently been proposed as a disposal technique that may aid in managing sand budgets on inlet and beachfront areas. Two types of berms have been proposed to date, one involving the creation of a long offshore berm, the second involving the placement of underwater berms along beachfronts bordering an inlet. These berms would theoretically reduce wave energy reaching the beaches and/or resupply sand to the system.

The Council recognizes offshore berm construction as a disposal activity. As such, all policies regarding disposal of dredged materials shall apply to offshore berm construction. Research should be conducted to quantify larval fish and crustacean transport and use of the inlets prior to any consideration of placement of underwater berms. Until the impacts of berm creation in inlet areas on larval fish and crustacean transport are determined, the Council recommends that disposal activities should be confined to approved ODMDSs. Further, new offshore and near shore underwater berm creation activities should be reviewed under the most rigorous criteria, on a case-by-case basis.

Maintenance Dredging and Sand Mining for Beach Renourishment
The Council recognizes that construction and maintenance dredging of the seaward portions of entrance channels and dredging borrow areas for beach re-nourishment occur in the EEZ. These activities should be done in an appropriate manner in accordance with the policies adopted by the Council.

The Council acknowledges that endangered and threatened species mortalities have occurred as a result of dredging operations. Considering the stringent regulations placed on commercial fisherman, dredging or disposal activities should not be designed or conducted so as to adversely impact rare, threatened or endangered species. NMFS Protected Species Division should work with state and federal agencies to modify proposals to minimize potential impacts on threatened and endangered sea turtles and marine mammals.

The Council has and will continue to coordinate with Minerals Management Service (MMS) in their activities involving exploration, identification and dredging/mining of sand resources for beach renourishment. This will be accomplished through membership on state task forces or directly with MMS. The Council recommends that live bottom/hard bottom habitat and historic fishing grounds be identified for areas in the South Atlantic region to provide for the location and protection of these areas while facilitating the identification of sand sources for beach renourishment projects.

Open Water Disposal
The SAFMC is opposed to the open water disposal of dredged material into aquatic systems which may adversely impact habitat that fisheries under Council jurisdiction are dependent upon. The Council urges state and federal agencies, when reviewing permits considering open water disposal, to identify the direct and indirect impacts such projects could have on fisheries habitat.

The SAFMC concludes that the conversion of one naturally functioning aquatic system at the expense of creating another (marsh creation through open water disposal) must be justified given best available information.

7.4.2.3 Policies for the Protection and Restoration of EFH from Energy Exploration, Development, Transportation and Hydropower Re-Licensing

Policy Context

This document establishes the policies of the South Atlantic Fishery Management Council (SAFMC) regarding protection of Essential Fish Habitat (EFH) and Essential Fish Habitat - Habitat Areas of Particular Concern (EFH-HAPCs) from threats associated with energy exploration, development, transportation and hydropower licensing. The policies are designed to be consistent with the overall habitat protection policies of the SAFMC as formulated and adopted in the Habitat Plan (SAFMC 1998a), the

Comprehensive EFH Amendment (SAFMC 1998b) and the various Fishery Management Plans (FMPs) of the Council.

The findings presented below assess the threats to EFH potentially posed by activities related to energy development and hydropower licensing in offshore and coastal waters, riverine systems, and adjacent wetland habitats, and the processes whereby those resources are placed at risk. The policies established in this document are designed to avoid, minimize, and offset damage caused by these activities, in accordance with the general habitat policies of the SAFMC as mandated by law. To address any future energy projects in the South Atlantic region, the SAFMC reserves the right to revise this policy when more information becomes available.

EFH At Risk from Energy Exploration, Development Transportation and Hydropower Licensing Activities

The SAFMC finds:

1. That oil or gas drilling for exploration or development on or closely associated with EFH including – but not limited to – coral, coral reefs, and live/hardbottom habitat at all depths in the Exclusive Economic Zone (EEZ), EFH-HAPCs, or other special biological resources essential to commercial and recreational fisheries under SAFMC jurisdiction, be prohibited.

2. That all facilities associated with oil and gas exploration, development, and transportation be designed to avoid impacts on coastal ecosystems and sand sharing systems.

3. That adequate spill containment and cleanup equipment be maintained for all development and transportation facilities and, that the equipment be available on-site or located so as to be on-site within the landing time trajectory. An environmental bond should be required to assure that adequate resources will be available for unanticipated environmental impacts, spill response, clean-up and environmental impact assessment.

4. That exploration and development activities should be scheduled to avoid migratory patterns, breeding and nesting seasons of endangered and threatened species, including – but not limited to – northern right whales in coastal waters off the southeastern United States.

5. That the Environmental Impact Statement (EIS) for any Lease Sale address impacts from activities specifically related to natural gas production, safety precautions required in the event of the discovery of “sour gas” or hydrogen sulfide reserves and the potential for transport of hydrocarbons to nearshore and inshore estuarine habitats resulting from the cross-shelf transport by Gulf Stream spin-off eddies. The EIS should also address the development of contingency plans to be implemented if

problems arise due to oceanographic conditions or bottom topography, the need for and availability of onshore support facilities in coastal areas, and an analysis of existing facilities and community services in light of existing major coastal developments.

6. That EISs prepared for liquefied natural gas (LNG) pipeline projects or other energy-related projects must fully describe direct and cumulative impacts to EFH, including deepwater coral communities. Impact evaluations should include quantitative assessments for each habitat based on recent scientific studies pertinent to that habitat, and the best available information.

7. That construction and operation of open-loop (flow-through) LNG processing facilities be prohibited in areas that support EFH.

8. That hydropower project licenses issued by the Federal Energy Regulatory Commission include specific terms and conditions to ensure that the amount and timing of river flows mimic natural conditions to the extent possible for protection of migratory diadromous fish species and their spawning habitats. In addition, the best available technologies that allow for safe, timely, and effective upstream and downstream fish passage should be integrated into the project design as specified in prescriptions issued by National Marine Fisheries Service.

9. That projects requiring expanded EFH consultation provide a full range of alternatives, along with assessments of the relative impacts of each on each type of EFH, EFH-HAPC and state-designated Critical Habitat Areas (CHAs).

10. That energy development activities have the potential to cause impacts to a variety of habitats across the shelf and to nearshore, estuarine, and riverine systems and wetlands, including:

    a) waters and benthic habitats in or near drilling and disposal sites, including those potentially affected by sediment movement and by physical disturbance associated with drilling activities and site development;
    b) waters and benthic habitats in or near LNG processing facilities or other energy development or transportation sites,
    c) exposed hardbottom (e.g. reefs and live bottom) in shallow and deep waters,
    d) coastal wetlands and
    e) riverine systems and associated wetlands.

11. That certain offshore, nearshore and riverine habitats are particularly important to the long-term viability of commercial and recreational fisheries under SAFMC management, and potentially threatened by oil and gas and other energy exploration, development, transportation, and hydropower licensing activities:

    a) coral, coral reef and live/hardbottom habitat, including deepwater coral communities,

b) marine and estuarine waters,
c) estuarine wetlands, including mangroves and marshes,
d) submersed aquatic vegetation,
e) waters that support diadromous fishes, and their spawning habitats
f) waters hydrologically and ecologically connected to waters that support EFH.

12. That siting and design of onshore receiving, holding, and transport facilities could have impacts on wetlands and endangered species' habitats if they are not properly located.

13. Sections of South Atlantic waters potentially affected by these projects, both individually and collectively, have been identified as EFH or EFH-HAPC by the SAFMC. Potentially affected species and their EFH under federal management include (SAFMC, 1998b):

    a) summer flounder (various nearshore waters, including the surf zone and inlets; certain offshore waters),
    b) bluefish (various nearshore waters, including the surf zone and inlets),
    c) red drum (ocean high-salinity surf zones and unconsolidated bottoms in the nearshore), (Myra, how about riverine and upper estuarine habitats frequented by red drum??
    d) many snapper and grouper species (live hardbottom from shore to 600 feet, and – for estuarine-dependent species (e.g., gag grouper and gray snapper) – unconsolidated bottoms and live hardbottoms to the 100 foot contour),
    e) black sea bass (various nearshore waters, including unconsolidated bottom and live hardbottom to 100 feet, and hardbottoms to 600 feet),
    f) penaeid shrimp (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas, including the surf zone and inlets), How about including estuarine emergent wetlands and deepwater habitats??
    g) coastal migratory pelagics (e.g., king mackerel, Spanish mackerel) (sandy shoals of capes and bars, barrier island ocean-side waters from the surf zone to the shelf break inshore of the Gulf Stream; all coastal inlets),
    h) corals of various types and associated organisms (on hard substrates in shallow, mid-shelf, and deepwater),
    i) muddy, silt bottoms from the subtidal to the shelf break, deepwater corals and associated communities),
    j) areas identified as EFH for Highly Migratory Species managed by the Secretary of Commerce (e.g., sharks: inlets and nearshore waters, including pupping and nursery grounds), and
    k) riverine areas that support diadromous fishes, including important prey species such as shad, herring and other alosines in addition to shortnose and Atlantic sturgeon.

14. Many of the habitats potentially affected by these activities have been identified as EFH-HAPCs by the SAFMC. Each habitat, type of activity posing a potential threat and FMP is provided as follows:

a) all nearshore hardbottom areas – exploration, transportation and development (SAFMC snapper grouper);
b) all coastal inlets – transportation and development (SAFMC penaeid shrimp, red drum, and snapper grouper);
c) nearshore spawning sites – transportation and development (SAFMC penaeid shrimps and red drum);
d) benthic Sargassum – exploration, transportation and development (SAFMC snapper grouper);
e) from shore to the ends of the sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras, North Carolina; Hurl Rocks, South Carolina; and *Phragmatopoma* (worm reefs) reefs off the central coast of Florida and near shore hardbottom south of Cape Canaveral – transportation and development (SAFMC coastal migratory pelagics);
f) Atlantic coast estuaries with high numbers of Spanish mackerel and cobia from ELMR, to include Bogue Sound, New River, North Carolina; Broad River, South Carolina – transportation and development (SAFMC coastal migratory pelagics);
g) Florida Bay, Biscayne Bay, Card Sound, and coral hardbottom habitat from Jupiter Inlet through the Dry Tortugas, Florida – exploration, transportation and development (SAFMC spiny lobster);
h) Hurl Rocks (South Carolina); The *Phragmatopoma* (worm reefs) off central east coast of Florida; nearshore (0-4 meters; 0-12 feet) hardbottom off the east coast of Florida from Cape Canaveral to Broward County; offshore (5-30 meters; 15-90 feet) hardbottom off the east coast of Florida from Palm Beach County to Fowey Rocks; Biscayne Bay, Florida; Biscayne National Park, Florida; and the Florida Keys National Marine Sanctuary – transportation and development (SAFMC Coral, Coral Reefs and Live Hardbottom Habitat); and
i) EFH-HAPCs designated for HMS species (e.g., sharks) in the South Atlantic region – exploration, transportation and development (NMFS Highly Migratory Species).

15. Habitats likely to be affected by oil and gas exploration, development and transportation, and hydropower re-licensing activities include many recognised in state level fishery management plans. Examples of these habitats include Critical Habitat Areas (CHAs) established by the North Carolina Marine Fisheries Commission, either in FMPs or in Coastal Habitat Protection Plans.

16. Scientists in east Florida have documented exceptionally important habitat values for nearshore hardbottom used by over 500 species of fishes and invertebrates, including juveniles of many reef fishes. Equivalent scientific work is just beginning in other South Atlantic states, but life histories suggest that similar habitat use patterns will be found.

17. Proposed Deepwater Coral HAPCs and the pelagic and benthic species including their early life stages are potentially affected by oil and gas exploration, development

and transportation, LNG development and alternative energy development including ocean current and wave energy facilities.

Threats to Marine and Estuarine Resources from Energy Exploration, Development, Transportation and Hydropower Licensing Activities (Revised Draft March 2008)

The SAFMC finds that energy exploration, development, transportation and hydropower licensing activities threaten or potentially threaten EFH through the following mechanisms:

1. Direct mortality and displacement of organisms at and near drilling, dredging, and/or trenching sites,

2. Deposition of fine sediments (sedimentation) and drilling muds down-current from drilling, dredging, trenching, and/or backfilling sites,

3. Chronic elevated turbidity in and near drilling, dredging, trenching, and/or backfilling sites,

4. Direct mortality of larvae, post-larvae, juveniles and adults of marine and estuarine organisms occurring from water intake, spills from pipelines, or from vessels in transit near or close to inlet areas,

5. Alteration of long-term shoreline migration patterns (with complex, often indeterminable, ecological consequences),

6. Burial of sensitive coral resources and associated habitat resulting from "frac-outs" associated with horizontal directional drilling,

7. Permanent conversion of soft bottom habitat to artificial hardbottom habitat through installing a hard linear structure (i.e., a pipe covered in articulated concrete mats),

8. Impacts to benthic resources from placement and shifting of pipelines and cables, and from other types of direct mechanical damage,

9. Alterations in amount and timing of riverflow and significant blockage or reduction in area of critical spawning habitat resulting from damming or diverting rivers, and

10. Alteration of community diversity, composition, food webs and energy flow due to addition of structure.

In addition, the interactions between cumulative and direct (lethal and sub-lethal) effects among the above-listed can affect the magnitude of the overall impacts. Such interactions may result in a scale of effect that is multiplicative rather than additive. Those effects are at present nearly completely unstudied.

Potential Impacts of Offshore Ocean Current Energy Installations on Benthic Resources (USDOI, MMS 2007a):

Construction

- Bottom disturbances from installation of foundations or anchoring systems and anchoring of construction and maintenance vessels
- Sediment disturbance and suspension during installation of foundations or anchoring systems
- Sound during pile driving or drilling
- Habitat loss from foundations and units attached to the seafloor to gather the power and feed to the transmission cable to shore
- Habitat disturbance during cable laying
- Introduction of hard substrates
- Habitat disturbance resulting from scour

Operation

- Operational sound and vibration
- Introduction of contaminants from use of antifouling coatings and cleaning of marine fouling
- Introduction of different communities from fouling growth on monopiles and scour protection around the foundation or anchoring systems

Potential Impacts to Fishery Resources from Ocean Current Installations:

Construction activities

- Habitat disturbance or loss from foundations, moorings, anchors, and cable laying
- Sound associated with pile driving and drilling

Operations activities

- Introduction of artificial hard substrates
- Scour impacts on benthic habitats
- EMF effects on sensitive species
- Collisions with moving parts
- Changes in water flow and pressures

Potential Impacts to Fishery Resources from Wave Installations:

- anchored on hard bottom, a more sensitive habitat than soft sediments, and could affect essential fish habitat and Habitat Areas of Particular Concern
- transmission cable cannot be buried in hard bottom areas, creating concerns for those species that have EMF sensitivities
- antifouling agents (e.g., Tri-butyl tin) have toxic effects on many marine and estuarine organisms, and specifically different life stages of fishes
- some of the devices that use overtopping as part of their process might entrain fish, primarily embryos and larvae, that live at the surface of the ocean

SAFMC Policies for Energy Exploration, Development, Transportation and Hydropower Licensing Activities

The SAFMC establishes the following general policies related to energy exploration, development, transportation, and hydropower licensing activities and related projects, to clarify and augment the general policies already adopted in the Habitat Plan and Comprehensive Habitat Amendment (SAFMC, 1998a; SAFMC, 1998b):

1. Projects should avoid, minimize, and – where possible – offset damage to EFH and EFH-HAPCs. This should be accomplished, in part, by integrating the best available and least impactive technologies into the construction design.
2. Agencies with oversight authority should require expanded EFH consultation for projects with the potential to significantly damage EFH. Projects requiring expanded EFH consultation should include detailed analyses for a full range of alternatives of possible impacts to each type of EFH, each EFH-HAPC and each CHA, including short and long-term effects and cumulative impacts at local, population and ecosystem scales. These analyses should utilize resource-protective assumptions and the best available science.
3. Projects should utilize the alternative that minimizes total impact EFH, EFH-HAPCs, and CHAs.
4. Projects should include detailed assessments of potentially unavoidable damage to EFH and other marine resources associated with the preferred or selected alternative and cumulative impacts, using conservative assumptions and the best available science.

5. Compensatory mitigation should not be considered until avoidance and minimization measures have been duly demonstrated. Compensatory mitigation should be required to offset losses to EFH, including losses associated with temporary impacts, and should take into account uncertainty and the risk of the chosen mitigation measures inadequately offsetting the impacts. Mitigation should be local, "up-front," and "in-kind," and include long-term monitoring to assess and ensure the efficacy of the mitigation program selected.

6. Projects should include pre-project, project-related, and post-project monitoring adequate to document pre-project conditions and the initial, long-term and cumulative impacts of the project on EFH.

7. All EFH assessments should be based upon the best available science, be conservative, and follow precautionary principles as developed for various Federal and State policies.

8. All EFH assessments should document the cumulative impacts associated with all natural and anthropogenic stressors on EFH, including other energy exploration, development, transportation, and re-licensing projects that are geographically and ecologically related.

9. Projects should comply with existing standards and requirements regulating domestic and international transportation of energy products including regulated waste disposal and emissions which are intended to minimize negative impacts on and preserve the quality of the marine environment.

10. Open-loop LNG processing facilities should be avoided in favor of closed-loop systems. Water intake associated with closed-loop should be minimized and the effects to fishery resources should be determined through baseline studies and project monitoring.

11. The original licensing or re-licensing of hydropower projects should provide for adequate and ecologically based instream flows, and safe, timely, and effective upstream and downstream fish passage.

12. Third party environmental inspectors should be required on all projects to provide for independent monitoring and permit compliance.

13. Resource sensitivity training modules should be developed specific to each project, construction procedures and habitat types found within the project impact area. This training should be provided to all contractors and sub-contractors that are anticipated to work in or adjacent to areas that support sensitive habitats.

The SAFMC recommends the following specific concerns and issues be addressed by the Federal Energy Regulatory Commission, Minerals Management Service, and/or the U.S. Army Corps of Engineers prior to approval of any license, application, or permit.

A. The following requirements should apply to any permit to drill any exploratory well or wells in any Lease Sale with the potential to affect EFH in the SAFMC's jurisdiction. These concerns and issues should also be included in a new EIS for any future Outer Continental Shelf (OCS) Leasing Plan:

1. Identification of the on-site fisheries resources, including both pelagic and benthic communities, that inhabit, spawn, or migrate through the lease sites with special focus on those specific lease blocks where industry has expressed specific interest in the pre-lease phases of the leasing process. Particular attention should be given to critical life history stages (i.e. eggs and larvae) that are most sensitive to oil spills and seismic exploration.

2. Identification of on-site or potentially affected state or federally-listed species (e.g. endangered, threatened, special concern, etc.), marine mammals, pelagic birds, diadromous fishes, and all species regulated under federal fishery management plans.

3. Determination of impacts of all exploratory and development activities on the fisheries resources prior to MMS approval of any applications for permits to drill in the Exploratory Unit area, including effects of seismic survey signals on fish behavior, eggs and larvae.

4. Identification of commercial and recreational fishing activities in the vicinity of the lease or Exploratory Unit area, their season of occurrence and intensity, and any impacts whether temporary or permanent on the potential to continue those activities associated with the project or activity.

5. Determination of the physical and chemical oceanographic and meteorological characteristics of the area through field studies by MMS or the applicant, including on-site direction and velocity of currents and tides, sea states, temperature, salinity, water quality, wind storms frequencies, and intensities and icing conditions. Such studies must be required prior to approval of any exploration plan submitted in order to have adequate information upon which to base decisions related to site-specific proposed activities. Studies should include detailed characterization of seasonal surface currents and likely spill trajectories.

6. Description of required monitoring activities to be used to evaluate environmental conditions, and assess the impacts of exploration activities in the lease area or the Exploratory Unit.

7. Identification of the quantity, composition, and method of disposal of solid and liquid wastes and pollutants likely to be generated by offshore, onshore, and transportation operations associated with oil and gas exploration development and transportation.

8. Development of an oil spill contingency plan which includes oil spill trajectory analyses specific to the area of operations, dispersant-use plan including a summary of toxicity data for each dispersant, identification of response equipment and strategies, establishment of procedures for early detection and timely notification of an oil spill, and "chain-of-command" and notification procedures inclusive of all local, state and federal agencies and agency personnel to be notified when an oil spill is discovered, as well as defined and specific actions to be taken after discovery of an oil spill.

9. Mapping of environmentally sensitive areas (e.g., spawning aggregations of snappers and groupers); coral resources and other significant benthic habitats (e.g., tilefish mudflats) along the edge of the continental shelf (including the upper slope); calico scallop, royal red shrimp, and other productive benthic fishing grounds; other special biological resources; and northern right whale calving grounds and migratory routes, and subsequent deletion from inclusion in the respective lease block(s).

10. Planning for oil and gas product transport should be done to determine methods of transport, pipeline corridors, and onshore facilities.

11. The applicant, or MMS, must provide an analysis of biological community dynamics, and pathways and flows of energy, to ascertain accumulation of toxins and impacts on biological communities.

12. Due to the critical nature of canyons and steep relief to important fisheries (e.g. billfishes, swordfish and tunas) an evaluation of shelf-edge and down-slope dynamics, and a resource assessment to determine transport and fate of contaminants should be required.

13. Discussion of the potential adverse impacts upon fisheries resources of the discharges of all drill cuttings and all drilling muds that may be approved for use in the lease area or the Exploration Unit, as well as discharges associated with production activities (i.e. produced waters). This should include: physical and chemical effects upon pelagic and benthic species and communities, including spawning behavior, effects on eggs and larval stages; effects upon sight-feeding species of fish; and analysis of methods and assumptions underlying the model used to predict the dispersion of discharged muds and cuttings from exploration activities.

14. Discussion of secondary impacts affecting fishery resources associated with onshore oil and gas related development such as storage and processing facilities, dredging and dredged material disposal, roads and rail lines, fuel and electrical transmission line routes, waste disposal, and others.

B. The following requirements should apply to any permit or license to construct LNG gas pipelines and related facilities with the potential to affect EFH in the SAFMC's jurisdiction:

1. The least damaging construction method for traversing reef tracts and deepwater corals should be integrated into the project design.

2. Hydrotest chemicals that may be harmful to fish and wildlife resources shall not be discharged into waters of the United States.

3. Geotechnical studies shall be completed to ensure that the geology of the area is appropriate for the construction method and that geological risks are appropriately mitigated.

4. All work vessels associated with construction that traverses any reef system should be equipped with standard navigation aids, safety lighting and communication equipment. A vessel monitoring system with global positioning system will be employed to continuously monitor all vessel movements and locations in real time.

5. Any anchor placement should completely avoid corals and be diver verified. In addition, measures to avoid anchor sweep should be developed and implemented.

6. Appropriate exclusion zones should be designated around sensitive marine habitats.

7. Pre- and post-project monitoring should be completed in addition to monitoring during construction. The pre-project monitoring should establish pre-project conditions; project monitoring should examine if unanticipated impacts are occurring and if corrective actions are needed; and post-project (immediate and long-term) monitoring should document impacts to resources resulting from the project, and any recovery from those impacts.

8. All feasible avoidance and minimization measures must be used to protect deepwater coral communities. Those measures must be fully described in detail prior to authorization of any permit or license.

9. A contingency plan should be required to address catastrophic blowouts or more chronic material losses from LNG facilities, including trajectory and other impact analyses and remediation measures and responsibilities.

10. Periodic long-term monitoring of pipelines and nearby deepwater resources should be conducted to evaluate the environmental effects of these installations on deepwater marine communities.

11. Appropriate mitigation should be developed in concert with the NMFS Habitat Conservation Division to offset unavoidable impacts.

C. The requirement listed below should apply to any relevant permit or license to construct windfarms or hydroturbine energy producing facilities with the potential to affect EFH in the SAFMC jurisdiction. To date, such projects are conceptual, yet reasonably foreseeable as future proposed actions. Given the existing information, it is reasonable to conclude that such projects may have an impact on EFH. However, at this time sufficient information is not available to make general project-type recommendations.

1. Submarine cables should be placed in a manner that avoids impacts to EFH; use of existing conduits is preferred over creating new conduits. The best available technologies should be used to install such cables to avoid and minimize temporary and long-term impacts to EFH. If placed on the seabed, cables should be anchored and/or stabilized, and stability analyses should be conducted to ensure that the cable can withstand a 100-year storm event in appropriate water depths.

2. Many of the areas designated as EFH are important to protected resources (e.g., endangered and threatened species and marine mammals) in the region. Direct and indirect impacts may result from noise, electromagnetic fields, vessel traffic, pollutants/water quality issues, alteration of the benthos and habitat degradation or habitat exclusion. The degree of impact can depend on the species, the type of turbine, the method of installation, site characteristics and the layout and size of the facility. Therefore, any EIS prepared for the construction, operation or decommissioning of a wind energy generating facility should include maps of species' ranges, migratory pathways, and use of habitat as part of an evaluation of direct and cumulative impacts to protected resources.

Alternative Energy Environmental Information Needs (USDOI, MMS 2007a):

1. Finer-grained data on the distribution and life history for key species in each regional ecosystem; environmental assessments for specific projects need more detailed data on benthic habitats and multiyear studies of seasonal abundance and distribution of key species of each resource.

2. Development of better field data collection methods for baseline studies and Post-construction monitoring surveys to improve the confidence of impact detection; study of highly mobile species in offshore areas is particularly difficult, requiring new approaches and technologies.

3. Focused laboratory studies to determine thresholds for potential effects resulting from exposure to the types and levels of sound and electromagnetic fields likely to be generated by different types of alternative energy devices in full-scale installations.4.

Development of protocols for field studies on potential effects from exposure to sound, electromagnetic fields, and obstructions on the behavior and survival of key species of each resource of concern.

5. Development of guidelines to set acceptable limits of direct, indirect, and cumulative impacts resulting from the installation and operation of offshore alternative energy projects; guidelines are needed for all types of potential impacts such as changes to the hydrodynamic climate, erosion of adjacent shorelines, habitat loss and alteration, avoidance and attraction behavior, mortality, aesthetics, and lost use.

D. The following requirements should apply to the initial licensing or re-licensing of hydropower plants on rivers draining to waters under SAFMC jurisdiction:

1. The construction of adequate fish passage facilities (ladders, lifts, bypasses and screens) should be provided to ensure safe, timely and effective passage of fish to and from vital upstream spawning and maturation habitats.
2. Adequate, ecologically based instream flows approximating natural conditions should be provided to protect, enhance, or restore important riverine spawning and maturation habitats affected or potentially affected by hydropower projects.

SAFMC Policy and Position on Previous Oil and Gas Exploration Proposals

The SAFMC urged the Secretary of Commerce to uphold the 1988 coastal zone inconsistency determination of the State of Florida for the respective plans of exploration filed with MMS by Mobil Exploration and Producing North America, Inc. for Lease OCS-G6520 (Pulley Ridge Block 799) and by Union Oil Company of California for Lease OCS-G6491/6492 (Pulley Ridge Blocks 629 & 630). Both plans of exploration involved lease blocks lying within the lease area comprising the offshore area encompassed by Part 2 of Lease Sale 116, and south of 26° North latitude. The Council's objection to the proposed exploration activities was based on the potential degradation or loss of extensive live bottom and other habitat essential to fisheries under Council jurisdiction.

The SAFMC also supported North Carolina's determination that the plans of exploration filed with MMS by Mobil Exploration and Producing North America, Inc. for Lease OCS Manteo Unit are not consistent with North Carolina's Coastal Zone Management program.

The Council has expressed concern to the Outer Continental Shelf Leasing and Development Task Force about the proposed area and recommended that no further exploration or production activity be allowed in the areas subject to Presidential Task Force Review (the section of Sale 116 south of 26° N latitude).

The following section addresses the recommendations, concerns and issues expressed by the South Atlantic Council (Source: Memorandum to Regional Director, U.S. Fish and Wildlife Service, Atlanta, Georgia from Regional Director, Gulf of Mexico OCS Region dated October 27, 1995):

"The MMS, North Carolina, and Mobil entered into an innovative Memorandum of Understanding on July 12, 1990, in which the MMS agreed to prepare an Environmental Report (ER) on proposed drilling offshore North Carolina. The scope of the ER prepared by the MMS was more comprehensive than an EIS would be. The normal scoping process used in preparation of a NEPA-type document would not only 'identify significant environmental issues deserving of study' but also 'de-emphasize insignificant issues, narrowing the scope' (40 CFR 1500.4) by scoping out issues not ripe for decisions.

Of particular interest to North Carolina are not the transient effects of exploration, but rather the downstream and potentially broader, long-term effects of production and development. The potential effects associated with production and development would normally be "scoped out" of the (EIS-type) document and would be the subject of extensive NEPA analysis only after the exploration phase proves successful, and the submittal of a full-scale production and development program has been received for review and analysis. The ER addressed three alternatives: the proposed Mobil plan to drill a single exploratory well, the no-action alternative and the alternative that the MMS approve the Mobil plan with specific restrictions (monitoring programs and restrictions on discharges). The ER also analyzes possible future activities, such as development and production, and the long-term environmental and socioeconomic effects associated with such activities. The MMS assured North Carolina that all of the State's comments and concerns would be addressed in the Final ER (USDOI 1990).

The MMS also funded a Literature Synthesis study (USDOI MMS 1993a) and a Physical Oceanography study (USDOI MMS 1994), both recommended by the Physical Oceanography Panel and the Environmental Sciences Review Panel (ESRP). Mobil also submitted a draft report to the MMS titled *Characterization of Currents at Manteo Block 467 off Cape Hatteras, North Carolina*. The MMS also had a Cooperative Agreement with the Virginia Institute of Marine Science to fund a study titled *Seafloor Survey in the Vicinity of the Manteo Prospect Offshore North Carolina* (USDOI MMS 1993b). The MMS had a Cooperative Agreement with East Carolina University to conduct a study titled *Coastal North Carolina Socioeconomic Study* (USDOI MMS 1993c). The above-mentioned studies were responsive to the ESRP's recommendations as well as those of the SAFMC and the State of North Carolina."

Copies of these studies can be acquired from the address below:
Minerals Management Service, Technical Communication Services
MS 4530 381 Elden Street
Herndon, VA 22070-4897 (703) 787-1080

In addition, by letter dated November 21, 2003, the SAFMC provided the following recommendations on the AES Ocean Express LNG pipeline project:

- The deepwater touch down route should be pre-inspected by ROV and the pipeline right of way shall be clear of all deepwater resources;
- Adjust deepwater touchdown position to maintain an appropriate buffer from any such deepwater resources;
- Require deepwater resources, other EFH and the deepwater touchdown position be mapped by ROV to confirm the resource position in relation to the installed pipeline;
- Conduct pre-installation video surveys to select the route that maximizes avoidance of these deepwater coral and live bottom habitats; and
- Monitor pipelines and nearby deepwater resources after installation to evaluate the environmental effects of these installations on deepwater marine communities.

References

SAFMC. 1998a. Final Habitat Plan for the South Atlantic region: Essential Fish Habitat requirements for fishery management plans of the South Atlantic Fishery Management Council. South Atlantic Fishery Management Council, 1 Southpark Cir., Ste 306, Charleston, SC 29407-4699. 457 pp. plus appendices.

SAFMC. 1998b. Final Comprehensive Amendment Addressing Essential Fish Habitat in Fishery Management Plans of the South Atlantic Region. Including a Final Environmental Impact Statement /Supplemental Environmental Impact Statement, Initial Regulatory Flexibility Analysis, Regulatory Impact Review, and Social Impact Assessment/Fishery Impact Statement. South Atlantic Fishery Management Council, 1 Southpark Cir., Ste 306, Charleston, SC 29407-4699. 136pp.

USDOI, MMS. 1990. Atlantic Outer Continental Shelf, Final Environmental Report on Proposed Exploratory Drilling Offshore North Carolina, Vols. I-III.

USDOI, MMS. 1993a. North Carolina Physical Oceanography Literature Study. Contract No. 14-35- 0001-30594.

USDOI, MMS. 1993b. Benthic Study of the Continental Slope Off Cape Hatteras, North Carolina. Vols. I-III. MMS 93-0014, -0015, -0016.

USDOI, MMS. 1993c. Coastal North Carolina Socioeconomic Study. Vols. I-V. MMS 93-0052, -0053, -0054, -0055, and -0056.

USDOI, MMS. 1994. North Carolina Physical Oceanographic Field Study. MMS 94-0047.

USDOI, MMS. 2007a. Michel, J., Dunagan, H., Boring, C., Healy, E., Evans, W., Dean, J.M., McGillis, A. and Hain, J. 2007. Worldwide Synthesis and Analysis of Existing Information Regarding Environmental Effects of Alternative Energy Uses on the Outer Continental Shelf. U.S. Department of the Interior, Minerals Management Service, Herndon, VA, MMS OCS Report 2007-038. 254 pp.

USDOI, MMS 2007b. Michel, J. and Burkhard, E. 2007. Workshop to Identify Alternative Energy Environmental Information Needs: Workshop Summary. U.S. Department of the Interior, Minerals Management Service, Herndon, VA, MMS OCS Report 2007-057. 50 pp. + appendices.

7.4.2.4 Policies for the Protection and Restoration of EFH from Alterations to Riverine, Estuarine and Nearshore Flows

Policy Context

This document establishes the policies of the South Atlantic Fishery Management Council (SAFMC) regarding protection of the essential fish habitats (EFH) and habitat areas of particular concern (EFH-HAPCs) associated with alterations of riverine, estuarine and nearshore flows. Such hydrologic alterations occur through activities such as flood control reservoir and hydropower operations, water supply and irrigation withdrawals, deepening of navigation al channels and inlets, and other modifications to the normative hydrograph. The policies are designed to be consistent with the overall habitat protection policies of the SAFMC as formulated and adopted in the Habitat Plan (October 1998) and the Comprehensive EFH Amendment (October 1998).

The findings presented below assess the threats to EFH potentially posed by activities related to the alteration of flows in southeast rivers, estuaries and nearshore ocean habitats, and the processes whereby those resources are placed at risk. The policies established in this document are designed to avoid, minimize and offset damage caused by these activities, in accordance with the general habitat policies of the SAFMC as mandated by law.

EFH At Risk from Flow-Altering Activities

The SAFMC finds:

1. In general, the array of existing and proposed flow-altering projects being considered for the Southeastern United States for states with river systems that drain into the South Atlantic Fishery Management Council area of jurisdiction together constitutes a real and significant threat to EFH under the jurisdiction of the SAFMC.

2. The cumulative effects of these projects have not been adequately assessed, including impacts on public trust marine and estuarine resources (especially diadromous species), use of public trust waters, public access, state and federally protected species, state critical habitat, SAFMC-designated EFH and EFH-HAPCs.

3. Individual proposals resulting in hydrologic alterations rarely provide adequate assessments or consideration of potential damage to fishery resources under state and federal management. Historically, emphasis has been placed on the need for human water supply, hydropower generation, agricultural irrigation, flood control and other human uses. Environmental considerations have been dominated by compliance with limitations imparted by the Endangered Species Act for shortnose sturgeon, and/or through provisions of Section 18 of the Federal Power Act, as administered by the Federal Energy Regulatory Commission, which applies to the provision of passage for anadromous species, as well as the provisions of the Fish and Wildlife Act.

4. Opportunities to avoid and minimize impacts of hydrologic alterations on fishery resources, and offsets for unavoidable impacts have rarely been proposed or implemented.

5. Hydrologic alterations have caused impacts to a variety of habitats including:

a. waters, wetlands and benthic habitats near the discharge and withdrawal points, especially where such waters are used for spawning by anadromous species;
b. waters, wetlands and benthic habitats in the area downstream of discharge or withdrawal points;
c. waters wetlands and benthic habitats in receiving estuaries of southeast rivers; and
d. waters and benthic habitats of nearshore ocean habitats receiving estuarine discharge.

6. Certain riverine, estuarine and nearshore habitats are particularly important to the long-term viability of commercial and recreational fisheries under SAFMC management, and threatened by large-scale, long-term or frequent hydrologic alterations:
    a. freshwater riverine reaches and/or wetlands used for anadromous spawning;
    b. downstream freshwater, brackish and mid-salinity portions of rivers and estuaries serving as nursery areas for anadromous and estuarine-dependant species; and
    c. nearshore oceanic habitats off estuary mouths.

7. Large sections of South Atlantic waters potentially affected by these projects, both individually and collectively, have been identified as EFH or EFH-HAPC by the SAFMC, as well as the Mid-Atlantic Fishery Management Council (MAFMC) in the case of North Carolina. Potentially affected species and their EFH under federal management include (SAFMC, 1998) include:
    a. summer flounder (various nearshore waters, including the surf zone and inlets; certain offshore waters).
    b. bluefish (various nearshore waters, including the surf zone and inlets)
    c. red drum (ocean high-salinity surf zones and unconsolidated bottoms in the nearshore).
    d. many snapper and grouper species (live hard bottom from shore to 600 feet, and – for estuarine-dependent species [e.g., gag grouper and gray snapper] – unconsolidated bottoms and live hard bottoms to the 100 foot contour).
    e. black sea bass (various nearshore waters, including unconsolidated bottom and live hard bottom to 100 feet, and hard bottoms to 600 feet).
    f. penaeid shrimp (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas, including the surf zone and inlets).
    g. coastal migratory pelagics (e.g., king mackerel, Spanish mackerel) (sandy shoals of capes and bars, barrier island ocean-side waters from the surf zone to the shelf break inshore of the Gulf Stream; all coastal inlets).
    h. corals of various types (hard substrates and muddy, silt bottoms from the subtidal to the shelf break).
    i. areas identified as EFH for Highly Migratory managed by the Secretary of Commerce (e.g., sharks / inlets and nearshore waters, including pupping and nursery grounds).

8. Projects which entail hydrologic alterations also threaten important fish habitats for anadromous species under federal, interstate and state management (in particular, riverine spawning habitats, riverine and estuarine habitats, including state designated areas - e.g. Primary and Secondary Nursery Areas of North Carolina), as well as essential overwintering grounds in nearshore and offshore waters. All diadromous species are under management by the Atlantic States Marine Fisheries Commission and the states. The SAFMC also identified essential habitats of anadromous and catadromous species in the region (inlets and nearshore waters).

9. Numerous habitats that have been by these projects causing hydrologic alterations have been identified as EFH-HAPCs by the SAFMC. The specific fishery management plan is provided in parentheses:
   a. all nearshore hard bottom areas (SAFMC, snapper-grouper).
   b. all coastal inlets (SAFMC, penaeid shrimps, red drum, and snapper-grouper).
   c. nearshore spawning sites (SAFMC, penaeid shrimps, and red drum).
   d. benthic *Sargassum* (SAFMC, snapper-grouper).
   e. from shore to the ends of the sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras, North Carolina; Hurl Rocks, South Carolina; *Phragmatopoma* (worm reefs) reefs off the central coast of Florida and near-shore hard-bottom south of Cape Canaveral (SAFMC, coastal migratory pelagics).
   f. Atlantic coast estuaries with high numbers of Spanish mackerel and Cobia from ELMR, to include Bogue Sound, New River, North Carolina; Broad River, South Carolina (SAFMC, coastal migratory pelagics).
   g. Florida Bay, Biscayne Bay, Card Sound, and coral hard bottom habitat from Jupiter Inlet through the Dry Tortugas, Florida (SAFMC, Spiny Lobster)
   h. Hurl Rocks (South Carolina), The Phragmatopoma (worm reefs) off central east coast of Florida, nearshore (0-4 meters; 0-12 feet) hard bottom off the east coast of Florida from Cape Canaveral top Broward County); offshore (5-30 meters; 15-90 feet) hard bottom off the east coast of Florida from Palm Beach County to Fowey Rocks; Biscayne Bay, Florida; Biscayne National Park, Florida; and the Florida Keys National Marine Sanctuary (SAFMC, Coral, Coral Reefs and Live hard Bottom Habitat).
   i. EFH-HAPCs designated for HMS species (e.g., sharks) in the South Atlantic region (NMFS, Highly Migratory Species).

10. Habitats likely to be affected by projects which alter hydrologic regimes include many recognized in state level fishery management plans. Examples of these habitats include Critical Habitat Areas established by the North Carolina Marine Fisheries Commission, either in FMPs or in Coastal Habitat Protection Plans.

Threats to Marine and Estuarine Resources from Hydrologically-Altering Activities

The SAFMC finds that activities which alter normative hydrologic regimes of rivers, estuaries, inlets and nearshore oceanic habitats threaten or potentially threaten EFH through the following mechanisms:

1. Direct mortality of organisms at withdrawal points through hydrologic regimes

In addition, the interactions between cumulative and direct (sub-lethal) effects among the above factors certainly trigger non-linear impacts that are completely unstudied.

SAFMC Policies for Flow-altering Projects

The SAFMC establishes the following general policies related projects resulting in hydrologic alterations, to clarify and augment the general policies already adopted in the Habitat Plan and Comprehensive Habitat Amendment (SAFMC 1998a; SAFMC 1998b):

1. Projects should avoid, minimize and where possible offset damage to EFH and EFH-HAPCs.
2. Projects requiring expanded EFH consultation should provide detailed analyses of possible impacts to each type of EFH, with careful and detailed analyses of possible impacts to EFH-HAPCs and state Critical Habitat Areas (CHAs), including short and long term, and population and ecosystem scale effects. Agencies with oversight authority should require expanded EFH consultation.
3. Projects requiring expanded EFH consultation should provide a full range of alternatives, along with assessments of the relative impacts of each on each type of EFH, HAPC and CHAs.
4. Projects should avoid impacts on EFH, HAPCs and CHAs that are shown to be avoidable through the alternatives analysis, and minimize impacts that are not.
5. Projects should include assessments of potential unavoidable damage to EFH and other marine resources, using conservative assumptions.
6. Projects should be conditioned on the avoidance of avoidable impacts, and should include compensatory mitigation for all reasonably predictable impacts to EFH, taking into account uncertainty about these effects. Mitigation should be local, up-front and in-kind, and should be adequately monitored, wherever possible.
7. Projects should include baseline and project-related monitoring adequate to document pre-project conditions and impacts of the projects on EFH.
8. All assessments should be based upon the best available science, and be appropriately conservative so follow and precautionary principles as developed for various federal and state policies.
9. All assessments should take into account the cumulative impacts associated with other projects in the same southeast watershed.

References

SAFMC. 1998a. Final habitat plan for the South Atlantic region: Essential Fish Habitat requirements for fishery management plans of the South Atlantic Fishery Management Council. 457 pp plus appendices.

SAFMC. 1998b. Final Comprehensive Amendment Addressing Essential Fish Habitat in Fishery Management Plans of the South Atlantic Region. Including a Final Environmental Impact Statement /Supplemental Environmental Impact Statement, Initial Regulatory Flexibility Analysis, Regulatory Impact Review, and Social Impact Assessment/Fishery Impact Statement. South Atlantic Fishery Management Council, 1 Southpark Cir., Ste 306, Charleston, S.C. 29407-4699. 136pp.

7.4.2.4 Policies for the Protection and Restoration of EFH from Marine Aquaculture

Policy Context

This document establishes the policies of the South Atlantic Fishery Management Council (SAFMC) regarding protection of Essential Fish Habitat (EFH) and Essential Fish Habitat - Habitat Areas of Particular Concern (EFH-HAPCs) from potential impacts associated with marine aquaculture. The policies are designed to be consistent with the overall habitat protection policies of the SAFMC as formulated in the Habitat Plan (SAFMC 1998a) and adopted in the Comprehensive EFH Amendment (SAFMC 1998b) and the various Fishery Management Plans (FMPs) of the Council.

The findings presented below assess potential impacts, negative and positive to EFH and EFH-HAPCs posed by activities related to marine aquaculture in offshore and coastal waters, riverine systems and adjacent wetland habitats, and the processes which could place those resources at risk. The policies and recommendations established in this document are designed to avoid, minimize, and offset potential impacts from these activities, in accordance with the general habitat policies of the SAFMC as mandated by law. To address any future marine aquaculture projects in the South Atlantic region, or as legislation is developed to provide additional guidelines, the SAFMC will revise this policy when more information becomes available.

The recommendations presented here should be applied to aquaculture facilities in reasonable proximity to EFH and EFH-HAPCs, however managed. Current laws, regulations and policies differ for offshore aquaculture, and for aquaculture activities in nearshore and inshore waters managed by the various states. As the federal FMPs in the region are amended to address offshore aquaculture as “fishing” activities, then these recommendations should be factored into those FMPs. Where aquaculture remains outside federal FMP-based management, then EFH protection mechanisms for “non-fishing” activities should be used to protect EFH, wherever possible.

EFH Potentially At Risk from Marine Aquaculture Activities

The SAFMC finds that:

EFH Potentially At Risk from Marine Aquaculture Activities

The SAFMC finds that:

1. Properly sited, designed and managed marine aquaculture operations can have beneficial economic and environmental outcomes. However, marine aquaculture activities or associated support facilities can have the potential to cause adverse impacts to a variety of habitats across the shelf and to nearshore systems including:

    a) waters and benthic habitats in or near marine aquaculture sites,
    b) exposed hardbottom (e.g. reefs and live bottom) in shallow and deep waters,
    c) submerged aquatic vegetation beds,
    d) shellfish beds,

e) spawning and nursery areas,
f) coastal wetlands, and
g) riverine systems and associated wetlands.

2. Certain offshore, nearshore and riverine habitats are particularly important to the long-term viability of commercial and recreational fisheries under SAFMC management, and are potentially threatened by marine offshore aquaculture activities, including:

   a) coral, coral reef and live/hardbottom habitat, including deepwater coral communities;
   b) marine and estuarine waters;
   c) estuarine wetlands, including mangroves and marshes;
   d) submerged aquatic vegetation;
   e) waters that support diadromous fishes, and their spawning and nursery habitats; and
   f) waters hydrologically and ecologically connected to waters that support EFH.

3. Construction and operation of poorly sited and/or designed aquaculture support facilities could adversely impact wetlands, other EFH and protected species' habitats.

4. Sections of South Atlantic waters potentially affected by these projects, both individually and collectively, have been identified as EFH or EFH-HAPC by the SAFMC. Potentially affected species and their EFH under federal management include (SAFMC, 1998b):

   a) summer flounder (various nearshore waters; certain offshore waters);
   b) bluefish (various nearshore waters);
   c) red drum (unconsolidated bottoms in the nearshore);
   d) many snapper and grouper species (live hardbottom from shore to 600 feet, and – for estuarine-dependent species (e.g., gag grouper and gray snapper) – unconsolidated bottoms and live hardbottoms to the 100 foot contour);
   e) black sea bass (various nearshore waters, including unconsolidated bottom and live/hardbottom to 100 feet, and hardbottoms to 600 feet);
   f) penaeid shrimp (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas);
   g) coastal migratory pelagics (e.g., king mackerel, Spanish mackerel) (sandy shoals of capes and bars, barrier island ocean-side waters from the surf zone to the shelf break inshore of the Gulf Stream);
   h) corals of various types and associated organisms (on hard substrates in shallow, midshelf, and deep water);
   i) muddy, silt bottoms from the subtidal to the shelf break, deepwater corals and associated communities; and

j) areas identified as EFH for Highly Migratory Species managed by the Secretary of Commerce (e.g., sharks: inlets and nearshore waters, including pupping and nursery grounds).

5. Many of the habitats potentially affected by these activities have been identified as EFH-HAPCs by the SAFMC. Each habitat and FMP is provided as follows:

a) all hardbottom areas (SAFMC snapper grouper);
b) nearshore spawning and nursery sites (SAFMC penaeid shrimps and red drum);
c) benthic Sargassum (SAFMC snapper grouper);
d) from shore to the ends of the sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras, North Carolina; Hurl Rocks, South Carolina; and Phragmatopoma (worm reefs) reefs off the central coast of Florida and near shore hardbottom south of Cape Canaveral (SAFMC coastal migratory pelagics);
e) Hurl Rocks (South Carolina); the Phragmatopoma (worm reefs) off central east coast of Florida; nearshore (0-4 meters; 0-12 feet) hardbottom off the east coast of Florida from Cape Canaveral to Broward County; offshore (5-30 meters; 15-90 feet) hardbottom off the east coast of Florida from Palm Beach County to Fowey Rocks; Biscayne Bay, Florida; Biscayne National Park, Florida; and the Florida Keys National Marine Sanctuary (SAFMC Coral, Coral Reefs and Live Hardbottom Habitat);
f) EFH-HAPCs designated for HMS species (e.g., sharks) in the South Atlantic region (NMFS Highly Migratory Species);
g) Oculina Bank HAPC and proposed deepwater coral HAPCs (SAFMC Coral, Coral Reefs and Live Hardbottom Habitat); and
h) HAPCs for diadromous species adopted by the Atlantic States Marine Fisheries Commission (ASMFC).

6. Habitats likely to be affected by marine aquaculture activities include many recognized in state-level fishery management plans and interstate fishery management plans of the ASMFC. Examples of these habitats include state-designated Critical Habitat Areas (CHAs) or Strategic Habitat Areas (SHAs) established by the North Carolina Marine Fisheries Commission, either in FMPs or in Coastal Habitat Protection Plans. Many state-managed and interstate-managed species serve as key prey for SAFMC-managed species.

7. Scientists have documented exceptionally important habitat values for East coast Florida nearshore hardbottom used by over 500 species of fishes and invertebrates, including juveniles of many reef fishes. Equivalent scientific work is just beginning in other South Atlantic states, but life histories suggest that similar habitat use patterns will be found.

Threats to EFH from Marine Aquaculture Activities

Aquaculture-related development without adequate safeguards may threaten wild stocks and the habitats that support them. The future of some aquaculture sectors is inextricably intertwined with fisheries and the health of marine ecosystems. Some coastal forms of aquaculture are known to degrade marine ecosystems, and may result in a net loss of fish. Finfish netpens in offshore waters may pose risks similar to netpens in inshore waters, where several potential environmental issues have been documented (summarized in Naylor et al., 2000; and Nash, ed, 2005).

Experimental or small-scale commercial fish farms are unlikely to have major environmental effects. However, if marine aquaculture booms, and becomes a major means of food production, the potential impacts on marine ecosystems and wild fisheries – and the communities that depend upon them – could be significant. An analysis of the potential cumulative impacts of aquaculture development in the Southeast region is essential prior to any large-scale expansion, onshore or offshore.

<u>The SAFMC finds the following to constitute potential threats to EFH:</u>
1) Escapement: Ecological damage caused by escaped organisms has been documented, including the introduction of non-native species, and reduced fitness of wild stocks as a result of interbreeding with escapees of the same species. The likelihood of escapes from farms may be high, if cages are sited in storm-prone areas, either offshore on nearshore.

Moreover, species potentially targeted for offshore or nearshore production may spawn in netpens. Ocean fish cages are incapable of containing fish eggs. The impacts of fertilized egg releases on the health of wild fisheries could be significant if farmed fish are genetically less well adapted to the ocean environment, as a result of selective breeding, genetic engineering, or simply because animals being farmed were taken from a geographic area with different ecological conditions

2) Spread of pathogens and use of antibiotics and other drugs: Concentration of large numbers of animals in a small area can facilitate outbreaks of disease and parasites, potentially jeopardizing wild stocks.
Disease and parasite outbreaks can also lead producers to administer antibiotics and other drugs, usually via feed. Drugs can end up in marine ecosystems where they can select for resistant bacteria, sometimes in species targeted by fisheries (Ervik et al., 1994). Note that the U.S. Food and Drug Administration regulates the use of drugs in aquaculture and there are only a very few drugs approved for controlled and limited use.

3) Water pollution: Concentrated animal production operations use substantial amounts of feeds. Even very efficient operations may lose a portion of the nutrients in feeds through uneaten food and through oxygen-demanding wastes, which are transmitted to surrounding waters.

Nitrogen is the nutrient primarily responsible for eutrophication in marine waters in the U.S. southeast, resulting in algal blooms and deoxygenation. In inshore waters, both nitrogen and phosphorus are nutrients of concern.

Nutrient impacts can be considerable in oligotrophic oceanic systems at levels significantly below those used as benchmarks for pollution in inshore and estuarine waters. The importance of the surface microlayer to larval ecology and its vulnerability to perturbations from airborne or locally-sourced excess nutrients cannot be overstated. Standards and criteria for nutrient-related water quality impacts on these oceanic ecological functions do not yet exist, and compliance with state-based water quality standards and national water quality criteria for nutrients may not prevent loading-based impacts.

Fish farms may cluster geographically near infrastructure such as processing plants and transportation, like terrestrial hog farms, concentrating potential impacts. However, widely-spaced marine farms sited in areas with strong currents and strong mixing would have less localized impact.

Finally, other feed additives, including metals and persistent organic pollutants, may contribute to longer-term bioaccumulation.

SAFMC Policies for Marine Aquaculture Projects

The SAFMC establishes the following general policies related to marine aquaculture projects, to clarify and augment the general policies already adopted in the Habitat Plan and Comprehensive Habitat Amendment (SAFMC 1998a; SAFMC 1998b):

1. The Council strongly supports thorough public review and effective regulation of marine aquaculture activities in the South Atlantic EEZ. South Atlantic fisheries are exceptionally dependent upon healthy habitat already under attack from many sources.

2. Permits should be for at least a ten-year duration with annual reporting requirements (activity reports) and a five-year comprehensive operational review with the option for revocation at any time in the event there is no prolonged activity or there is documented adverse impacts to marine resources. Given the changes underway in coastal ecosystems in response to storm events, rising seas and introduced species, such a review cycle is essential.

3. Environmental review and performance expectation are paramount. This is a new and totally optional class of private uses being imposed on already at-risk ecosystems where unacceptable ecological cascades could occur. The Council is committed to ensuring that marine aquaculture activities are held to the same level of EFH conservation protections as are other non-fishing[*] activities.

[*] The reference to non-fishing activities is meant to clarify that the Council's role is to comment on aquaculture activities similar to process the Council uses for non-fishing activities. The MSA currently defines aquaculture as a fishing activity. However, the proposed Aquaculture Bill would remove aquaculture as a fishing activity. The Council applies the same EFH standards to both fishing and non-fishing impacts.

4. The Council approves of use of therapeutic agents and feed additives that have been approved by the FDA specifically for use in offshore open-water or net pen aquaculture.

5. The use of genetically modified and non-native species should be prohibited.

6. Given the critical nature of proper siting, the applicant should provide all needed information to evaluate in full the suitability of potential sites. If sufficient information is not provided in the application review time allotted by existing processes, the permit should be denied or held in abeyance until required information is available.

7. Monitoring plans should be developed by the applicant/permit holder and approved by NOAA Fisheries with input from the Council. Monitoring plans should be reviewed, approved, and funded prior to implementation.

8. Permitees must have adequate resources legally committed to ensure proper decommissioning of obsolete or storm-damaged facilities.

9. The issuing agency should have clear authority to repeal or condition permits in order to prevent environmental damage and exercise its authority to repeal permits if it becomes evident that environmental damage is occurring or if permit conditions are not met.

References

Arnold, W., M. White, H. Norris, M. Berrigan. 2000. Hard clam (Mercenaria spp.) aquaculture in Florida, U.S.A: geographic information system applications to lease site selection. Aquacultural Engineering 23:203-231

Atlantic States Marine Fisheries Commission. 2002. Guidance Relative to Development of Responsible Aquaculture Activities in Atlantic Coast States. Special Report No. 76 of the Atlantic States Marine Fisheries Commission, Washington, D.C. 74 pages

Ervik, A., Thorsen, B., Eriksen, V., Lunestad, B.T., Samuelsen, O.B. 1994. Impact of administering antibacterial agents on wild fish and blue mussels Mytilus edulis in the vicinity of fish farms. Diseases of Aquatic Organisms 18:45-51.

Florida Department of Agriculture. 2005. Aquaculture Best Management Practices Rule, January 2005. Division of Aquaculture, Florida Department of Agriculture, Tallahassee, FL. 104 pages

Goldburg, R., Naylor, R. 2005. Transformed seascapes, fishing, and fish farming. Frontiers in Ecology and the Environment 3:21-28.

Krosek, M., Lewis, M.A., Volpe, J.. 2005. Transmission dynamics of parasitic sea lice from farm to wild salmon. Proceedings of the Royal Society. Series B. Biological Sciences 272:689-696.

Marine Aquaculture Task Force. 2007. Sustainable Marine Aquaculture: Fulfilling the Promise; Managing the Risks. Woods Hole Oceanographic Institute, Woods Hole, MA.128 pages

Nash, C.E., P.R. Burbridge, and J.K. Volkman (editors). 2005. Guidelines for ecological risk assessment of marine fish aquaculture. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-71. 90 pages

Naylor, R.L., Goldburg, R.J., Primavera, J., Kautsky, N., Beveridge, M., Clay, J., Folke, C., Mooney, H., Lubchenco, J., Troell, M. 2000. Effect of Aquaculture on World Fish Supplies. Nature 405: 1017-1024.

Naylor, R., Hindar, K., Fleming, I., Goldburg, R., Mangel, M., Williams, S., Volpe, J.,Whoriskey, F., Eagle, J., Kelso, D. 2005. Fugitive Salmon: Assessing Risks of Escaped Fish from Aquaculture. BioScience 55:427-437.

Naylor, R., Burke, M. 2005. Aquaculture and ocean resources: Raising tigers of the sea. Annual Review of Environmental Resources 30:1.1.1.34

Naylor, R. L. 2006. Environmental safeguards for open-ocean aquaculture. Issues in Science and Technology. Spring issue: 53-58.

Nesheim, M, and A. Yaktine (editors). 2007. Seafood Choices: Balancing Benefits and Risks. Institute of Medicine of the National Academies, National Academy Press, Washington, D.C. 722 pages

SAFMC.1998a. Final Habitat Plan for the South Atlantic region: Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council. South Atlantic Fishery Management Council, 1 Southpark Circle, Suite 306, Charleston, SC 29407-4699. 457 pp. plus appendices.

SAFMC. 1998b. Final Comprehensive Amendment Addressing Essential Fish Habitat in Fishery Management Plans of the South Atlantic Region. Including a Final Environmental Impact Statement /Supplemental Environmental Impact Statement, Initial Regulatory Flexibility Analysis, Regulatory Impact Review, and Social Impact Assessment /Fishery Impact Statement. South Atlantic Fishery Management Council, 1 Southpark Circle, Suite 306, Charleston, SC 29407-4699. 136pp.

Stickney, R., B. Costa-Pierce, D. Baltz, M. Drawbridge, C. Grimes, S. Phillips, and D.L. Swann. 2006. Toward sustainable open ocean aquaculture in the United States. Fisheries 31: 607-610

U.S. Department of Agriculture. 2006. Census of Aquaculture (2005). 2002 Census of Agriculture. Volume 3, Special Studies. Part 2. AC-02-SP-2

7.4.3 Activity-based policies

(Source: the Habitat Plan SAFMC, 1998a)

7.4.3.1 Docks and Piers

Docks and piers, whether built over or floating on the water, are generally acceptable methods of gaining access to deep water. General considerations include:

1. Docks and piers should be constructed so that waterflow restriction and blockage of sunlight on wetland surfaces is avoided or minimized;

2. Docks and piers should be of adequate length to reach navigational depths without increasing dredging needs; and

3. Docks and piers should be designed and located to avoid areas that support submerged aquatic vegetation, shellfish beds and harvest areas, and other fragile and productive habitats.

7.4.3.2 Boat Ramps

1. Sites should be located along shorelines that do not support wetland vegetation and where adjacent waters have adequate navigational depths. Acceptable sites may include existing marinas; bridge approaches and causeways (with highway agency approval) where construction access channels exist; and natural and previously created deep water habitats;

2. Preferably, sites should be restricted to areas that do not require dredging to gain access to navigable waters. When located in the vicinity of seagrass beds, adequate navigation channels must exist and should be clearly marked. Boat ramps should not be located in areas where boats will encroach on sensitive and productive habitats;

3. Ramps should not be located in areas where encroachment into wetlands is likely to occur. Sites should contain adequate upland area for parking and for boat launching/removal; and

4. Adequate waste collection facilities should be required at public facilities.

7.4.3.3 Marinas

All marinas adversely affect aquatic habitats to some degree. These effects can be minimized through proper location and design. In addition to applicable recommendations for boat ramps, bulkheads, and seawalls, the following apply:

1. Marinas should be located in areas where suitable physical conditions exist. For example, potential sites should be located close to navigable waters and in

locations where marina-related activities would not affect living marine resource forage, cover, harvest, and/or nursery habitats. Attention also should be given to sediment deposition rates and maintenance dredging requirements;

2. Marinas should be located at least 1,000 feet from shellfish harvest areas, unless state regulations or other considerations specify differently;

3. Dry-stack storage is generally preferable to wet mooring of boats. Open dockage extending into deep water is generally preferable to basin excavation;

4. Mooring basins should be sited in uplands rather than wetlands, and they should be designed so that water quality degradation does not occur. This may require consideration of basin flushing characteristics and incorporation of other design features such as surface and waste water collection and treatment facilities;

5. Turning basins and navigation channels should not create sumps and other slack-water areas that could degrade water quality nor should they be located in areas where circulation is poor. Depths generally should not exceed those of adjoining waters and, where practicable, they should provide for light penetration that is capable of sustaining benthic plant life. Dissolved oxygen levels in channels and basins should be adequate for fish and macroinvertebrate survival;

6. Consideration should be given to aligning access channels and configuring marinas to take full advantage of circulation from prevailing summer winds;

7. Permanent dredged material disposal sites (for use in initial and maintenance dredging) that do not impact wetland areas should be identified and acquired. Suitable disposal alternatives include placing dredged material on uplands, and using dredged material to create/restore wetlands. Projects that lack permanent disposal sites should not be authorized if maintenance dredging is needed and disposal sites/options are not available;

8. Catchment basins for collecting and storing surface runoff should be included as components of the site development plan. Marine railways or upland repair facilities should be equipped with hazardous material containment facilities so that biocides such as marine paints, oil and grease, solvents, and related materials are not directly or indirectly discharged into coastal waters and wetlands;

9. Consideration should be given to parking and other support facilities when it appears that available uplands are not adequate to support such needs and wetland encroachment is anticipated;

10. Marinas with fueling facilities should be designed to include practical measures for reducing oil and gas spillage into the aquatic environment. Spill control plans may be needed when marina facilities are to be located in the vicinity of large,

emergent wetland areas, shellfish harvest sites, and other fragile/productive aquatic sites; and

11. Facilities for collection of trash and potential marine debris should be required. Where vessels with marine toilets will be moored, pump out facilities and notices regarding prohibition of sewage and other discharges should be provided.

7.4.3.4 Bulkheads and Seawalls

Bulkheads are used to protect adjacent shorelines from wave and current action and to enhance water access. Applications for bulkheads usually specify construction in open water followed by placing fill material behind the structure. Bulkheads may adversely impact wetlands through direct filling; through isolation; and through exacerbation of wave scour. Adverse impacts may be reduced by applying the following criteria:

1. Except in cases of recent and rapid erosion, structures should be aligned at or shoreward of the normal high waterline. Structures should be constructed so that reflective wave energy does not scour or otherwise adversely affect adjacent EFH or wetlands. For example, in areas that support fringing wetlands consideration should be given to the use of breakwaters (with regular openings -- see item 3 below) or placement of riprap at the toe of the bulkhead or along the waterward edge of eroding wetlands;

2. Where possible, sloping (3:1) riprap, gabions, or vegetation should be used rather than vertical seawalls; and

3. Shoreline protection devices that are located in areas having fringe wetlands should have openings that allow for fish ingress and egress and water circulation. Recommended spacing for structure openings is no less than one linear foot per five linear feet of structure.

7.4.3.5 Cables, Pipelines, and Transmission Lines

Wetland excavation is sometimes required for installing submerged cables, pipelines, and transmission lines. Construction also may require temporary or permanent wetlands filling. The following recommendations apply:

1. Wetland crossings should be aligned along the least environmentally damaging route. Submerged aquatic vegetation, shellfish beds, coral reefs, etc., must be avoided;

2. Construction of permanent access channels should be avoided since they disrupt natural drainage patterns and destroy wetlands through direct excavation, filling, and bank erosion. The push-ditch method, in which the trench is immediately backfilled, reduces the impact duration;

3. Excavated wetlands should be backfilled with either the same material as removed or a comparable material that is capable of supporting suitable replacement wetlands. Original marsh elevations should be restored and, where

practicable, excavated vegetation should be stockpiled, kept viable, and returned to the excavated site. After backfilling, erosion protection measures should be implemented where needed to prevent fish habitat degradation and loss;

4. Excavated materials should be stored on uplands. If storage in wetlands cannot be avoided, discontinuous stock-piles should be used to allow continuation of sheet flow. Where practicable, stockpiled materials should be stored on construction cloth rather than bare marsh surfaces. Topsoil and organic surface material such as root mats should be stockpiled separately and returned to the surface of the restored site;

5. In open-water areas, excavated materials should be deposited in discontinuous piles to preclude significant blockage of water movement. Back-filling is recommended if the excavated material would alter circulation patterns or interfere with fishing;

6. Use of existing rights-of-way should be recommended when use of these areas would lessen overall wetland encroachment and disturbance; and

7. Directional drilling, a technique that allows horizontal, sub-surface, placement of pipelines should be used in situations where normal trenching and backfill would cause unacceptable levels of habitat loss or alteration.

7.4.3.6 Transportation

State and federal highway agencies generally have the capability of conducting advanced planning with road, causeway, and bridge construction. To the extent possible, NMFS Branch Office and USFWS personnel should participate in early planning efforts. Since highway projects are generally considered to be in the public interest and frequently require wetland crossings, identification of mitigation needs, and development of suitable mitigation plans should be undertaken early in the planning process. The following criteria should be considered:

1. Transportation corridors/facilities should avoid wetlands. Where wetland crossings cannot be avoided, bridging should be used rather than filling, and the least environmentally damaging route, preferably along existing rights-of-way and road beds, should be followed;

2. Disrupting or reducing fish and invertebrate migration routes should be avoided. In areas that support or could support anadromous fish migrations, low, narrow, and/or dark passageways such as culverts and small bridges should not be utilized unless aligned and designed so that elimination of or significant reductions in fish migrations do not occur;

3. Structures should be designed to prevent shoaling and alteration of natural water circulation. Suitable erosion control and vegetation restoration should be implemented at wetland crossings; and

4. Transportation facilities should be designed to accommodate other public utilities, thus avoiding the need for additional wetland alteration. An example would be using bridges to support transmission lines and pipelines.

7.4.3.7 Navigation Channels and Boat Access Canals

Construction and maintenance of navigation channels and boat access canals may cause severe environmental harm. In addition to direct habitat losses associated with wetland and deepwater excavation and filling, these activities may significantly modify salinity and water circulation patterns. These changes could greatly modify the distribution and abundance of living marine resources. The following criteria should be followed:

1. Where possible, dredging should be minimized through the use of natural and existing channels;

2. Alignments should avoid sensitive habitats such as shellfish beds, finfish and invertebrate nurseries, submerged aquatic vegetation, and emergent wetlands;

3. Permanent dredged material disposal sites should be located in non-wetland areas. Where long-term maintenance excavation is anticipated, disposal sites should be acquired and maintained for the entire project life;

4. Boat access canals should be designed to ensure adequate flushing and should be uniform in depth or made progressively deeper in the direction of receiving waters. Where possible, they should be aligned to take advantage of wind and lunar tides;

5. Construction techniques that minimize turbidity and dispersal of dredged materials into sensitive wetland areas (e.g., submerged grasses and shellfish beds) are encouraged. Work should be scheduled to avoid periods of high biological activity such as fish and invertebrate migration and spawning;

6. Care should be taken to avoid adverse alteration of tidal circulation patterns, salinity regimes, or other factors that influence local ecological and environmental conditions;

7. Channels and access canals should not be constructed in areas known to have high sediment contaminant levels. If construction must occur in these areas, consideration should be given to the use of silt curtains or other techniques needed to contain suspended contaminants; and

8. Use of sidecast dredges should be confined to areas such as inlets and open water areas where benthic communities are limited and hopper or pipeline dredging is not possible.

7.4.3.8 Disposal of Dredged Material

Previous and on-going disposal of dredged material is a major contributor to wetland losses in marine and estuarine ecosystems. Recognizing that most navigation channels and access canals require periodic maintenance dredging, it is important that long-range plans be developed and that they provide for mitigation of unavoidable adverse environmental impacts. Implementing the following criteria would minimize adverse impacts associated with most dredged material disposal activities:

1. Dredged material should be viewed as a potentially reusable resource and beneficial uses of these materials should be encouraged. Materials that are suitable for beach replenishment, construction, or other useful purposes should be placed in accessible non-wetland disposal areas;

2. Disposal sites that are located in unprotected coastal areas and adjacent to wetlands are especially susceptible to wind and water erosion. These forces can carry substantial quantities of dredged material into aquatic habitats. If located near wetlands, disposal site surfaces should be stabilized using vegetation or other means to eliminate possible erosion or encroachment onto adjacent wetlands;

3. Dredged material should be placed in contained upland sites or approved open-water locations where adverse impacts to living marine resources are minimal. When placed in open water, dredged material should be used to enhance marine fishery resources. For example, materials could be used to renourish eroding wetlands or to fill previous borrow sites;

4. The capacity of existing disposal areas should be used to the fullest extent possible. This may necessitate increasing the elevation of embankments to augment the holding capacity of the site and applying techniques that render dredged material suitable for export or for use in reestablishing wetland vegetation;

5. Where possible, outfalls should be positioned so that they discharge into the dredged area or other sites that lack biological/ecological significance. When evaluating potential upland disposal sites, the possibility of saltwater intrusion into ground water and surrounding freshwater habitats should be assessed by the construction/regulatory agencies. Groundwater contamination could necessitate redesign of disposal practices, with subsequent harm to living marine resources; and

6. Toxic and highly organic materials should be disposed in impervious containment basins located on upland. Effluent should be monitored to ensure compliance with state and federal water quality criteria and measures should be incorporated to ensure that surface runoff and leachate from dredged material disposal sites do not enter aquatic ecosystems.

7.4.3.9 Impoundments and Other Water-Level Controls

1. Wetland impoundments:

Thousands of wetland acres are impounded each year in the Southeast for purposes such as waterfowl habitat creation, aquaculture, agriculture, flood control, hurricane protection, mosquito control, and control of marsh subsidence and erosion. Projects range in size from minor, such as repair of existing embankments, to large-scale marsh management projects where constructing dikes and water- control structures may affect thousands of wetland acres.

Proposals to impound or control marsh water levels should contain water management plans with sufficient detail to determine the accessibility of impounded areas to marine organisms and the degree to which detrital and nutrient export into adjacent estuarine areas will be affected. Significant adverse impacts can be avoided or minimized with implementation of the following recommendations:

a. Proposals to impound or reimpound previously unimpounded wetlands are unacceptable unless designed to accommodate (1) normal access and wetland use by marine fish and invertebrates and (2) continuation of other biological interaction, such as nutrient exchange, and other similarly important physical and chemical interactions; and

b. Proposals to repair or replace water control structures will be assessed on a case-by-case basis.

2. Watershed Impoundments:

Water-development agencies sometimes propose impounding rivers, bayous, and tributaries for such purposes as flood control or creation of industrial, municipal, and agricultural water supplies. Activities of this type are usually unacceptable because associated alteration of the quality, quantity, and timing of freshwater flow into estuaries may cause large-scale adverse modification or elimination of estuarine and marine habitats. Such actions also may block fish and invertebrate migrations.

7.4.3.10 Drainage Canals and Ditches

Drainage canals may be important components of upland development. Their potential to shunt polluted runoff and fresh water directly into tidal waters requires intermediate connection to retention ponds or wetlands. This allows natural filtration and assimilation of pollutants and dampening of freshwater surges prior to discharge into tidal waters. Recommendations include:

1. Drainage canals that dewater or cause other adverse wetland impacts are unacceptable and should not be built;

2. Drainage canals and ditches from upland development generally should not extend or discharge directly into wetlands;

3. Constructing upland retention ponds and other water management features such as sheet-flow diffusers is encouraged. A retention pond or other pollution elimination/assimilation structure should be required if the effluent contains or may contain materials that are toxic to marsh vegetation or other aquatic life,

4. Excavated materials resulting from canal and retention pond construction should be placed on upland or used to restore wetlands;

5. Proposed drainage plans should be in accordance with comprehensive flood plain management plan(s) and applicants should be encouraged to consult with the EPA and appropriate state agencies to ensure that federal and state water quality standards are met;

6. Locating mosquito control ditches in wetlands should be discouraged. If built, they should be designed so that they do not drain coastal wetlands. They also should be designed to avoid water stagnation, and they should provide access for aquatic organisms that feed on mosquito larvae; and

7. Use of innovative techniques such as rotary ditching, spray dispersal of dredged materials, and open-water marsh management should be encouraged where appropriate.

7.4.3.11 Oil and Gas Exploration and Production

Exploration and production of oil and gas resources in wetlands usually have adverse impacts since excavation and filling are generally required to accommodate access and production needs. In open marine waters, dredging and filling is usually not necessary, but special stipulations are required to minimize adverse impacts to living marine resources. In addition to the above recommendations for navigation channels, access canals, and pipeline installation, the following apply:

1. In coastal wetlands:
    a. Activities should avoid wetland use to the extent practicable. Alternatively, the use of uplands, existing drilling sites and roads, canals, and naturally deep waters should be encouraged. When wetland use is unavoidable, work in unvegetated and disturbed wetlands is generally preferable to work in high quality and undisturbed wetlands;

    b. Temporary roadbeds (preferably plank roads) generally should be used instead of canals for access to well sites;

    c. Water crossings should be bridged or culverted to prevent alteration of natural drainage patterns;

    d. Culverts or similar structures should be installed and maintained at sufficient intervals (never more than 500-feet apart) to prevent blockage of surface drainage or tidal flow;

e. Petroleum products, drilling muds, drill cuttings, produced water, and other toxic substances should not be placed in wetlands;

f. If the well is productive, the drill pad and levees should be reduced to the minimum size necessary to conduct production activities; and

g. Defunct wells and associated equipment should be removed and the area restored to the extent practicable. Upon abandonment of wells in coastal wetlands, the well site, various pits, levees, roads, and work areas should be restored to preproject conditions by restoring natural elevations and planting indigenous vegetation whenever practicable. Abandoned well access canals should generally be plugged at their origin (mouths) to minimize bank erosion and saltwater intrusion, and spoil banks should be graded back into borrow areas or breached at regular intervals to establish hydrological connections.

2. In open estuarine waters:
    a. Activities in estuarine waters should be conducted as follows:

    b. Existing navigable waters already having sufficient width and depth for access to mineral extraction sites should be used to the extent practicable;

    c. Petroleum products, drilling muds, drill cuttings, produced water, and other toxic substances should not be placed in wetlands; and

    d. Defunct equipment and structures should be removed.

3. On the continental shelf:
    a. Activities should be conducted so that petroleum-based substances such as drilling mud, oil residues, produced waters, or other toxic substances are not released into the water or onto the sea floor. The following measures may be recommended with exploration and production activities located close to hard banks and banks containing reef building coral:

    b. Drill cuttings should be shunted through a conduit and discharged near the sea floor, or transported ashore or to less sensitive, NMFS-approved offshore locations. Usually, shunting is effective only when the discharge point is deeper than the site that is to be protected;

    c. Drilling and production structures, including pipelines, generally should not be located within one mile of the base of a live reef;

    d. All pipelines placed in waters less than 300 feet-deep should be buried to a minimum of three feet beneath the sea floor, where possible. Where this is not possible and in deeper waters where user-conflicts are likely, pipelines should be marked by lighted buoys and/or lighted ranges on platforms to reduce the risk of damage to fishing gear and the pipelines. Pipeline alignments should be located along routes that minimize damage to marine and estuarine habitat. Buried pipelines should be examined periodically for maintenance of adequate earthen cover.

7.4.3.12 Other Mineral Mining/Extraction

1. Proposals for mining mineral resources (sand, gravel, shell, phosphate, etc.) from or within 1,500 feet of exposed shell reefs and vegetated wetlands, and within 1,500 feet of shorelines are unacceptable except when the material is to be used for oyster cultch; and

2. All other proposals will be considered on a case-by-case basis.

7.4.3.13 Sewage Treatment and Disposal

Urbanization and high density development of coastal areas has resulted in a substantial increase in proposals to construct sewage treatment and discharge facilities in coastal wetlands. Since many of these facilities utilize gravity flow systems for movement of waste water and materials, wetlands and other low-lying areas are often targeted as sites for placement of pipelines and treatment facilities. Since pipelines and treatment facilities are not water dependent with regard to positioning, it is not essential that they be placed in wetlands or other fragile coastal habitats. The guidance provided in the Section on "Cables, Pipelines, and Transmission Lines," also applies to sewage collector and discharge pipelines. The following guidance should be considered with other aspects of sewage treatment and discharge:

1. Discharges should be treated to the maximum extent practicable, including implementation of up-to-date methodologies for reducing discharges of biocides (e.g., chlorine) and other toxic substances;

2. Use of land treatment and upland disposal/storage techniques should be implemented where possible. Use of vegetated wetlands as natural filters and pollutant assimilators for large scale discharges should be limited to those instances where other less damaging alternatives are not available and the overall environmental and ecological suitability of such an action has been demonstrated;

3. Discharging into open ocean waters is generally preferable to discharging into estuarine waters since discharging into estuarine waters is more likely to result in living marine resources contamination and nutrient overloading. Discharge points in coastal waters should be located well away from shellfish beds, seagrass beds, coral reefs, and other similar fragile and productive habitats. Proposals to locate outfalls in coastal waters must be accompanied by hydrographic studies that demonstrate year round dispersal characteristics and provide proof that effluents will not reach or affect fragile and productive habitats.

7.4.3.14 Steam-Electric Plants and Other Facilities Requiring Water for Cooling or Heating

Facilities that require substantial intake and discharge of water, especially heated and chemically-treated discharge water, are generally not suited for construction and operation in estuarine and near-shore marine environments. Major adverse impacts may be caused by impingement of organisms on intake screens; entrainment of organisms in heat-exchange systems or discharge plumes; and through the discharge of toxic materials in discharge waters. Protected Species Branch personnel should be notified of such projects early in the planning process since the operation of steam-electric plants often affects endangered species such as shortnose sturgeon and West Indian manatee. Projects that must be sited in the coastal zone and utilize estuarine and marine waters are subject to the following recommendations:

1. Facilities that rely on surface waters for cooling should not be located in areas such as estuaries, inlets, or small coastal embayments where fishery organisms are concentrated. Discharge points should be located in areas that have low concentrations of living marine resources, or they should incorporate cooling towers that employ sufficient safeguards to ensure against release of blow-down pollutants into the aquatic environment;

2. Intakes should be designed to minimize impingement. Velocity caps that produce horizontal intake/discharge currents should be employed and intake velocities across the intake screen should not exceed 0.5 feet per second;

3. Discharge temperatures (both heated and cooled effluent) should not exceed the thermal tolerance of the majority of the plant and animal species in the receiving body of water;

4. The use of construction materials that may release toxic substances into receiving waters should be minimized. The use of biocides (e.g., chlorine) to prevent fouling should be avoided where possible and least damaging antifouling alternatives should be implemented; and

5. Intake screen mesh should be sized to avoid entrainment of most larval and post-larval marine fishery organisms. Acceptable mesh size is generally in the range of 0.5 mm and rarely exceeds 1.0 mm in estuarine waters or waters that support anadromous fish eggs and larvae.

7.4.3.15 Mariculture/Aquaculture

The culture of estuarine and marine species in coastal areas can reduce or degrade habitats used by native stocks of commercially and recreationally important fisheries. The following criteria should be employed to reduce or eliminate adverse impacts:

1. Facilities should be located on upland. Tidally influenced wetlands should not be enclosed or impounded for mariculture purposes. This includes hatchery and grow-out operations;

2. Water intakes should be designed to avoid entrainment and impingement of native fauna;

3. Water discharge should be treated to avoid contamination of the receiving water, and should be located only in areas having good mixing characteristics;

4. Where cage mariculture operations are undertaken, water depths and circulation patterns should be investigated and should be adequate to preclude the buildup of waste products, excess feed, and chemical agents; and

5. Mariculture sites should be stocked with hatchery-reared organisms only. Non-native species should be certified to be disease free, and project design features that minimize escape or accidental release of cultured species should be required. The rearing of ecologically undesirable species is unacceptable since escape and accidental release of these species is virtually assured.

7.4.3.16 Mitigation

Sections 7.4.3.1 – 7.4.3.15 provide specific guidance for avoiding and reducing adverse impacts to fishery resources and their habitats. Compensatory mitigation is considered in cases where a resource is not unique and irreplaceable and 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 Council on Environmental Quality Recommendations. Those recommendations define mitigation as a sequential process whereby impacts are avoided, minimized, rectified, reduced over time, or are offset through compensation.

Despite increasing use of mitigation to offset wetland and other losses, there are situations (e.g., projects affecting seagrass) where the affected habitats are of such enormous value that the anticipated adverse impacts cannot be offset. In instances involving such unique and irreplaceable resources, mitigation is not acceptable. There is also disagreement over the functional equivalency of created and natural wetlands and it should not be assumed they are equivalent in habitat value.

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. 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 destroyed emergent and, to a lesser degree, submerged vegetation is a feasible and recognized option when implemented 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 ratio of at least two acres of mitigation for each acre of habitat destroyed should be recommended. 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:

1. 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.

2. 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.

   NMFS and USFWS consider the overall ecological and environmental implications of its recommendations, including upland impacts. Mitigation that may alleviate impacts to aquatic environments, but cause significant adverse impacts to important upland habitats should be carefully evaluated.

3. Size - The habitat to be restored or created should be at least twice the (areal) size of that which would be destroyed. 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 is also designed to address the possibility that the overall, long-term functional and ecological value of replacement habitats may be less than those of the impacted wetlands at the worksite.

4. 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.

Interest in the use of "mitigation banks" or created/restored wetlands that are intended for use in offsetting anticipated future wetland losses is increasing nationwide. Because of the complexity of developing and administering mitigation banks, guidance concerning their creation is beyond the scope of this document. NMFS Southeast Region Habitat Conservation Division Branch Office personnel that are participating in such efforts should consult early with other NMFS office personnel that have undertaken or are involved in such efforts since reliance on existing mitigation banking agreements may be beneficial. Habitat Conservation Division Branch Office personnel also should notify other participating agencies that signatory authority for mitigation bank agreements rests with the Regional Director. In all cases, consideration of mitigation banks should be guided by the principle that no net-loss of wetlands would be incurred.

7.5 Interagency and Interstate Policies

7.5.1 Joint Agency Habitat Statement

The SAFMC has endorsed a "Joint Statement to Conserve Marine, Estuarine, and Riverine Habitat" to promote interagency coordination in the preservation, restoration, and enhancement of fishery habitat. This statement as adopted by state, Federal, and regional bodies concerned over fishery habitat, is presented in Appendix VII of The Fishery Management Plan for Shrimp (SAFMC 1993a).

7.5.2 Atlantic States Marine Fisheries' Commission Seagrass Policy and Implementation Plan

The Atlantic States Marine Fisheries Commission seagrass policy (June 1997) is available at http://www.asmfc.org/publications/habitat/savpolicy.pdf The Policy is based on a collection of review papers that investigated the ecological value of SAV, its importance to Commission managed species, human impacts to SAV, and its regulation by state agencies. The SAV Policy establishes recommendations for protection and conservation of SAV by emphasizing assessment of SAV resources, protection of existing SAV, SAV restoration, public education, and scientific research. As directed in the SAV Policy, the Commission developed a document titled *Evaluate Fishing Gear Impacts to Submerged Aquatic Vegetation and Determining Mitigation Strategies* (July 2000). This document is available at http://www.asmfc.org/.

7.6 Federal Habitat Protection Laws, Programs and Policies

(Source: SAFMC Habitat Plan 1998).

The Clean Water Act (CWA) 33 U.S.C. s/s 121 et seq. (1977)

The Clean Water Act is a 1977 amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating discharges of pollutants to waters of the United States. This law gave EPA the authority to set effluent standards on an industry-by-industry basis (technology-based) and continued the requirements to set water quality standards for all contaminants in surface waters. The CWA makes it unlawful for any person to discharge any pollutant from a point source into navigable waters unless a permit (NPDES) is obtained under the Act. The 1977 amendments focused on toxic pollutants. In 1987, the CWA was reauthorized and again focused on toxic substances, authorized citizen suit provisions, and funded sewage treatment plants (POTWs) under the Construction Grants Program. The CWA provides for the delegation by EPA of many permitting, administrative, and enforcement aspects of the law to state governments. In states with the authority to implement CWA programs, EPA still retains oversight responsibilities.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) 42 U.S.C. s/s 9601 et seq. (1980)
CERCLA (pronounced SERK-la) provides a federal "Superfund" to clean up uncontrolled or abandoned hazardous waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through the Act, EPA was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup. EPA cleans up orphan sites when potentially responsible parties (PRPs) cannot be identified or located, or when they fail to act. Through various enforcement tools, EPA obtains private party cleanup through orders, consent decrees, and other small party settlements. EPA also recovers costs from financially viable individuals and companies once a response action has been completed. EPA is authorized to implement the Act in all 50 states and U.S. territories. Superfund site identification, monitoring, and response activities in states are coordinated through the state environmental protection or waste management agencies.

The Emergency Planning and Community Right-to-know Act (EPCRA) 42 U.S.C. 11011 et seq. (1986)
Also known as Title III of SARA, EPCRA was enacted by Congress as the national legislation on community safety. This law was designed to help local communities protect public health, safety, and the environment from chemical hazards. To implement EPCRA, Congress required each state to appoint a State Emergency Response Commission (SERC). The SERCs were required to divide their states into Emergency Planning Districts and to name a Local Emergency Planning Committee (LEPC) for each district. Broad representation by fire fighters, health officials, government and media representatives, community groups, industrial facilities, and emergency managers ensures that all necessary elements of the planning process are represented.

The Endangered Species Act 7 U.S.C. 136; 16 U.S.C. 460 et seq. (1973)
The Endangered Species Act provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The U.S. Fish and Wildlife Service (FWS) of the Department of Interior maintains the list of 632 endangered species (326 are plants) and 190 threatened species (78 are plants). Species include birds, insects, fish, reptiles, mammals, crustaceans, flowers, grasses, and trees. Anyone can petition FWS to include a species on this list or to prevent some activity, such as logging, mining, or dam building. The law prohibits any action, administrative or real, that results in a "taking" of a listed species, or adversely affects habitat. Likewise, import, export, interstate, and foreign commerce of listed species are all prohibited. EPA's decision to register a pesticide is based in part on the risk of adverse effects on

endangered species as well as environmental fate (how a pesticide will affect habitat). Under FIFRA (see below), EPA can issue emergency suspensions of certain pesticides to cancel or restrict their use if an endangered species will be adversely affected. Under a new program, EPA, FWS, and USDA are distributing hundreds of county bulletins which include habitat maps, pesticide use limitations, and other actions required to protect listed species. In addition, we are enforcing regulations under various treaties, including the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The U.S. and 70 other nations have established procedures to regulate the import and export of imperiled species and their habitat. The Fish and Wildlife Service works with U.S. Customs agents to stop the illegal trade of species, including the Black Rhino, African elephants, tropical birds and fish, orchids, and various corals.

The Federal Insecticide, Fungicide and Rodenticide act (FIFRA) 7 U.S.C. s/s 135 et seq. (1972)
The primary focus of FIFRA was to provide federal control of pesticide distribution, sale, and use. EPA was given authority under FIFRA not only to study the consequences of pesticide usage but also to require users (farmers, utility companies, and others) to register when purchasing pesticides. Through later amendments to the law, users also must take exams for certification as applicators of pesticides. All pesticides used in the U.S. must be registered (licensed) by EPA. Registration assures that pesticides will be properly labeled and that, if used in accordance with specifications, will not cause unreasonable harm to the environment.

The (Federal) Freedom of Information Act (FOIA) U.S.C. s/s 552 (1966)
The Freedom of Information Act provides specifically that “any person” can make requests for government information. Citizens who make requests are not required to identify themselves or explain why they want the information they have requested. The position of Congress in passing FOIA was that the workings of government are “for and by the people” and that the benefits of government information should be made available to everyone. All branches of the federal government must adhere to the provisions of FOIA with certain restrictions for work in progress (early drafts), enforcement confidential information, classified documents, and national security information.

The National Environmental Policy Act (NEPA) 42 U.S.C. s/s 4321 et seq. (1969)
The National Environmental Policy Act was one of the first laws ever written that establishes the broad national framework for protecting our environment. NEPA’s basic policy is to assure that all branches of government give proper consideration to the environment prior to undertaking any major federal action which significantly affects the environment. NEPA requirements are invoked when airports, buildings, military complexes, highways, parkland purchases, and other such federal activities are proposed. Environmental Assessments (EAs) and Environmental Impact Statements (EISs), which are assessments of the likelihood of impacts from alternative courses of action, are required from all federal agencies and are the most visible NEPA requirements.

The Occupational Safety and Health Act 29 U.S.C. 61 et seq. (1970)

Congress passed the Occupational and Safety Health Act to ensure worker and workplace safety. Their goal was to make sure employers provide their workers a place of employment free from recognized hazards to safety and health, such as exposure to toxic chemicals, excessive noise levels, mechanical dangers, heat or cold stress, or unsanitary conditions. In order to establish standards for workplace health and safety, the Act also created the National Institute for Occupational Safety and Health (NIOSH) as the research institution for the Occupational Safety and Health Administration (OSHA). OSHA is a division of the U.S. Department of Labor which over-sees the administration of the Act and enforces federal standards in all 50 states.

The Pollution Prevention Act 42 U.S.C. 13101 and 13102, s/s 6602 et seq. (1990)
The Pollution Prevention Act focused industry, government, and public attention on reducing the amount of pollution produced through cost-effective changes in production, operation, and raw materials use. Opportunities for source reduction are often not realized because existing regulations, and the industrial resources required for compliance, focus on treatment and disposal. Source reduction is fundamentally different and more desirable than waste management or pollution control. Pollution prevention also includes other practices that increase efficiency in the use of energy, water, or other natural resources, and protect our resource base through conservation. Practices include recycling, source reduction, and sustainable agriculture.

The Resource Conservation and Recovery Act (RCRA) 42 U.S.C. s/s 321 et seq. (1976)
RCRA (pronounced "rick-rah") gave EPA the authority to control hazardous waste from "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites (see CERCLA).

<u>HSWA (pronounced "hiss-wa") – The federal Hazardous and Solid Waste Amendments</u>
The 1984 amendments to RCRA required phasing out land disposal of hazardous waste. Some of the other mandates of this strict law include increased enforcement authority for EPA, more stringent hazardous waste management standards, and a comprehensive underground storage tank program.

The Safe Drinking Water Act (SDWA) 43 U.S.C. s/s 300f et seq. (1974)
The Safe Drinking Water Act was established to protect the quality of drinking water in the U.S. This law focuses on all waters actually or potentially designated for drinking use, whether from above ground or underground sources. The Act authorized EPA to establish safe standards of purity and required all owners or operators of public water systems to comply with primary (health-related) standards. State governments, which assume this power from EPA, also encourage attainment of secondary standards (nuisance-related).

The Superfund Amendments and Reauthorization Act (SARA) 42 U.S.C. 9601 et seq. (1986)
The Superfund Amendments and Reauthorization Act of 1986 reauthorized CERCLA to continue cleanup activities around the country. Several site-specific amendments, definitions, clarifications, and technical requirements were added to the legislation, including additional enforcement authorities. Title III of SARA also authorized the Emergency Planning and Community Right-to-Know Act (EPCRA).

The Toxic Substances Control Act (TSCA) 15 U.S.C. s/s 2601 et seq. (1976)
The Toxic Substances Control Act of 1976 was enacted by Congress to test, regulate, and screen all chemicals produced or imported into the U.S. Many thousands of chemicals and their compounds are developed each year with unknown toxic or dangerous characteristics. To prevent tragic consequences, TSCA requires that any chemical that reaches the consumer market place be tested for possible toxic effects prior to commercial manufacture. Any existing chemical that poses health and environmental hazards is tracked and reported under TSCA. Procedures also are authorized for corrective action under TSCA in cases of cleanup of toxic materials contamination. TSCA supplements other federal statutes, including the Clean Air Act and the Toxic Release Inventory under EPCRA.

7.7 State Habitat Protection Programs

7.7.1 North Carolina

The Coastal Area Management Act was passed in 1974 to protect North Carolina's fragile coastal resources through planning and management at the state and local level. The Department of Environment, Health and Natural Resources administers the program. Policy direction is provided by the Coastal Resources Commission, a group of citizens appointed by the Governor. The Division of Coastal Management (DCM), under authority from the Coastal Resources Commission (CRC), is responsible for implementing the North Carolina Coastal Management Program for the protection, preservation, orderly development and management of the state's twenty coastal counties. DCM is part of the Department of Environment, Health and Natural Resources. Activities of DCM include: permitting and enforcing regulations in areas of environmental concern; reviewing consistency of government and larger private activities in the coastal zone for compliance with the Coastal Area Management Act; planning for the ocean resources in North Carolina's jurisdictional waters; providing for effective disposal of boat sewage; identifying high priority watersheds; developing strategies for managing secondary and cumulative impacts; Transferring technology and information to local governments; identifying wetlands in the coastal area; assessing the relative significance of wetlands on the landscape; and identifying and prioritizing wetland restoration sites.

7.7.2 South Carolina

The Office of Ocean and Coastal Management implements the Coastal Management Act. The Office has authority to formulate and implement a comprehensive coastal management program and direct control through a permit program that oversees activities in critical areas that include coastal waters, tidelands, beaches, and primary ocean-front sand dunes. Indirect management authority of coastal resources is granted to the Office in counties containing one or more of the critical areas. In issuing permits, the Coastal Management Act requires that the Office consider the effects of proposed alterations on the production of fish, shrimp, oysters, crab, or any marine life, wildlife, or other natural resources.

7.7.3 Georgia

On April 22, 1997, Governor Miller signed the Georgia Coastal Management Act into law which established the Department of Natural Resources Coastal Resource Division as the authority to create the program, receive and dispense funds, and to coordinate with federal and state agencies regarding Coastal Management issues. On January 26, 1998 the Georgia Coastal Management Program received official approval. This approval marked the end of a six year combined effort by state and local government in partnership with private citizens to develop an integrated, networked program. The program uses existing State laws to manage Georgia's critical coastal resources. With the approval of the Georgia Coastal Management Program comes over $1 million in federal funds annually. Most of the funds are allocated to local communities and organizations through the "Coastal Incentive Grant" program. Incentive grants are presented to local governments and universities to address critical local issues in coastal Georgia such as water management, local government planning and small scale construction projects.

7.7.4 Florida

The Florida Legislature adopted the Florida Coastal Management Act in 1978. This act authorized the development of a coastal management program and its submittal to the appropriate federal agency. In 1981, the Florida Coastal Management Program (FCMP) was approved by the Secretary of the United States Department of Commerce. Florida's goal in creating the FCMP was not to create a new agency or new statutes concerned with coastal issues, but instead to use existing agencies and laws to address Florida's coastal needs. Florida's rules and laws adequately protected the coast, but were not always effectively implemented because of breakdowns in communication between agencies and administrative shortcomings. The FCMP was created to bridge these gaps and to open the lines of communication among the agencies so that their actions could be coordinated. The FCMP, as it exists today, is a network of ten state agencies and five water management districts using 23 statutes to protect Florida's coastal interests. The agencies most directly involved in issues that affect Essential Fish Habitat are listed below.

The Department of Community Affairs (DCA) is the lead agency for the FCMP, serving as coordinator of coastal issues and as the liaison between the state agencies and the federal government. DCA also houses the State Clearinghouse and serves as the state's land planning agency and emergency management agency.

The Department of Environmental Protection (DEP), formed by the merger of the former Department of Environmental Regulation and the former Department of Natural

Resources, serves as the state's chief environmental regulatory agency and the manager and steward of many of its natural resources. Among the natural resources over which the DEP has jurisdiction are submerged lands within state estuarine and marine waters. The Department of Health regulates on-site sewage disposal. The Marine Fisheries Commission exercises jurisdiction over saltwater fisheries and marine mammals. The five water management districts, organized along watershed lines, act in partnership with DEP in regulating activities in wetlands and waters of the state and the use of water resources.

8.0 Fisheries Management Evaluation and Recommendations

8.1 Area Management in the South Atlantic Region

8.1.1 South Atlantic Fishery Management Council

8.1.1.1 SMZs

Since 1983, the Council has allowed the designation of SMZs as an incentive to create artificial reefs and fish attraction devices to increase the numbers of fish in an area and/or create fishing opportunities that would not otherwise exist.

Designation of an area as a SMZ allows for gear restrictions in the area to prevent overexploitation. Many of these areas have been established through cooperation with fishing organizations and local governments and serve as a means to promote localized conservation and positive fishing experiences. A total of 51 SMZs have been designated off South Carolina, Georgia and Florida.

8.1.1.2 MPAs

(Source: Historical Overview of the South Atlantic Fishery Management Council's Marine Protected Areas Related Activities: 1990-2006)

The timeline below summarizes the Council's activities pertaining to the designation of Marine Protected Areas in the South Atlantic region from 1990 through 2006. This timeline highlights the transparency of the process that the Council undertook. For more information, including minutes from meetings and background documentation, please go to www.safmc.net.

1990 - The potential for using marine reserves within the snapper grouper fishery first originated with the Council's Snapper Grouper Plan Development Team (PDT). This technical group prepared a report (April 1990) entitled "The Potential of Marine Fishery Reserves for Reef Fish Management in the U.S. South Atlantic." The Plan Development Team offered this approach because they believed it was the only viable option for maintaining optimum size, age, and genetic structure of slow growing, long-lived species over the long-term. The Council received an extensive briefing on marine reserves at the February 1990 Council meeting. This provided an opportunity for the Council to discuss marine reserves as a concept and to hear about experiences with marine reserves in other parts of the world.

1992 - Marine reserves were initially considered as a possible option in early discussions on Amendment 4 to the Snapper Grouper Fishery Management Plan, however the Council determined the reserve concept should be addressed separately and scheduled scoping meetings in each of the states. During 1992 the Council held scoping meetings. Scoping meetings are less formal than public hearings and occur prior to the Council taking any position on a management issue. When the Council is considering the need for management, scoping meetings provide an opportunity for members of the public to make suggestions BEFORE the Council has made any decisions.

1993 - During the 1992 scoping process support for and against the concept surfaced. The Council reviewed the scoping information at the January 1993 meeting and decided to (1) recommend to National Marine Fisheries Service that they convene a Scientific Review Panel to review the concept of Marine Reserves and (2) drop consideration of the marine reserve concept at that time.

1994 - The previously designated Oculina Bank Habitat Area of Particular Concern (HAPC) off Ft. Pierce in eastern-central Florida was declared the Experimental Oculina Research Reserve (EORR). This area, measuring 4 x 23 nautical miles with depths between 30 and 75 fathoms, was closed to bottom fishing for a period of 10 years to allow for scientific studies in a closed area. The 10 year "sunset" was specified to ensure establishment of a proper research and evaluation program. In 1995, the closure was extended to include all anchoring within the boundaries of the experimental closed area. The area was closed to bottom fishing to enhance stock stability and increase recruitment by providing an area where deep water species (snowy grouper, golden tilefish, speckled hind and Warsaw, misty and yellowedge groupers) can grow and reproduce without being subjected to fishing mortality. Virtually any level of fishing mortality results in a large reduction in numbers of males and an altered size, age, and genetic structure. This effect is magnified when fishing in areas where these groupers gather for spawning. Such spawning aggregations have been observed in the Oculina Habitat Area of Particular Concern.

1995 - A scientific review of the 1990 Snapper Grouper Plan Development Team report was completed by the Scientific Review Panel as requested by the Council. The panel consisted of international experts with different experience in fishery science, marine reserves, ecology, fish genetics, sociology, and economics.

The Scientific Review Panel concluded that properly designed marine reserves in combination with other management measures can be an effective management tool for reef fish resources in the U.S. South Atlantic region subject to the following conditions: (a) biological, ecological, social, and economic objectives of the reserves are clearly specified; (b) the relative biological, ecological, and economic impacts of reserves in the context of other fishery management measures have been estimated for various constituents; and (c) the development of marine reserve proposals proceed with the involvement of all constituencies and stakeholders.

Also the scientific review panel concluded that recognizing the alarming declines in stocks of key fishery species, the panel would urge that reserve options be considered immediately as part of a comprehensive fisheries management plan to prevent irreversible loss to species and fisheries.

1997 - In further developing Snapper Grouper Amendment 8 (and later Amendment 9), the Council realized that severe impacts would be felt by fishermen if necessary percentage reductions in catches of overfished species were imposed to achieve the mandated fishery management goals. Marine reserves once again surfaced as a potential alternative to fisheries closures.

Also in 1997 the Council accepted portions of the final Management Plan for the Florida Keys National Marine Sanctuary that designated one larger reserve that extended into the Council's jurisdiction and 12 small "preservation areas" that also function as marine reserves. These areas are being evaluated and will be reexamined at a five year review.
1998 - After deciding to reconsider the possibilities of marine reserves, the Council proceeded to take steps to initiate a fact-finding process using the Marine Reserves Committee and the Advisory Panel.

1999 - In May 1999, the Marine Reserves Advisory Panel unanimously passed a motion confirming that the Panel believes there is potential in using marine reserves as a fishery management tool.

2000 - The Council then laid out a deliberative process by which they would determine if marine protected areas were a tool that they should use to manage fisheries in the South Atlantic. This process included a series of informal meetings that Council members and staff attended in the spring of 2000. Any organizations that requested to could have a Council member and/or staff member come and talk with them about the potential use of marine protected areas. It was the Council's intent to begin a dialogue with stakeholders on ways to solve the overfishing problems in the South Atlantic Snapper Grouper Fishery and to ask the public if they thought marine protected areas may be one answer to a complex problem.

The stakeholders voiced many different opinions on the use of marine protected areas. There was an equal amount of support and opposition for no-take marine protected areas, but many variations were offered from all sides. Many groups were in support of protecting known spawning areas from fishing, and creating artificial habitats and prohibiting fishing in these areas. The responses the Council heard from the more formal scoping meetings they held later in the spring of 2000 were similar.
In September of 2000, after reviewing comments received from the informal meetings and scoping meetings, the Council voted to move forward with the use of marine protected areas.

2001 through 2003 - In the Spring of 2001 the Council held a final round of nine scoping meetings. The public was provided charts that showed known hardbottom areas off the South Atlantic coast and was asked to use their experience and knowledge of snapper grouper species (specifically deepwater snapper grouper species) to suggest areas the Council may want to consider designating as marine reserves. As a part of this scoping process, the Marine Reserves Advisory Panel was asked to also suggest areas. As a result of this process over 40 sites were suggested and originally considered as potential marine reserves.

At their February 2001 meeting, the Council's Marine Reserves Committee discussed the difficulty managers and stakeholders were facing given that many different agencies were looking at marine reserves, marine sanctuaries, marine protected areas, etc. The different nomenclature associated with this management tool made things very confusing to the public and managers alike. The Committee determined that the term "marine reserves" was coming to imply an area that allowed no fishing. This was contrary to the Council's definition and intent. In order to be more consistent with national definitions the Council adopted the term Marine Protected Areas (MPAs).

During 2001 and into 2002 the Council, with help from its advisors, began working to determine which sites would best meet the Council's management objective to protect deepwater snapper grouper species. In August of 2001 the Council held an unprecedented "Mega-AP" meeting of the Habitat, Coral, Snapper Grouper, MPA, Law Enforcement, and Wreckfish Advisory Panels (APs). The APs were asked to help the Council select sites that would be the most beneficial for overfished, deepwater snapper grouper species using their various and vast knowledge, understanding that the Council's intent was to look at sites that protect more inshore snapper grouper species further down the line (that is, in the future).

Later in 2001 the Snapper Grouper Assessment Group, the Scientific and Statistical Committee, and the Snapper Grouper AP met with the Council's Snapper Grouper Committee to provide additional input on possible MPA sites. Based on input from the SSC, APs, and the Snapper Grouper Committee, the Council instructed staff to develop an options paper for Snapper Grouper Amendment 14 with an initial level of analysis of sites the Council felt met the criteria of protecting overfished, deepwater snapper grouper species.

2004 - The sites that met the criteria of protecting overfished, deepwater snapper grouper species were included in the Informational Public Hearing Document and taken out to public hearings in early 2004. At those public hearings social and economic data were collected to help staff refine sites and analyze the impacts of the proposed sites.
The information gathered at the Informational Public Hearings was useful in helping staff begin to assess the social and economic impacts of each individual site. It became clear that the location of a few of the sites may need to be tweaked in order to achieve the Council's goals and lessen social and economic impacts.

2005 - At their September 19-23 Council meeting in Charleston, South Carolina the Council voted to include MPAs as an approach to manage deepwater snapper grouper species in Snapper Grouper Amendment 13B. Of the nine sites originally proposed to be considered, only eight were to be included in Amendment 13B. The site not carried forward was a proposed artificial reef MPA two miles off the North Carolina coast. The Council felt that this site did not meet the criteria of protecting deepwater snapper grouper species.

At the December 5-9 Council meeting in Carolina Beach, North Carolina the Council voted to move consideration of MPAs into a separate Snapper Grouper Amendment 14 to address deepwater Type II MPAs.

2006 - At the March 2nd Council meeting in Jekyll Island, Georgia the Council reviewed a draft of Snapper Grouper Amendment 14 and approved motions to: (a) add a monitoring plan to the research needs section and (b) add alternatives to look at Vessel Monitoring Systems (VMS) for snapper grouper vessels with a snapper grouper permit and bottom longline gear onboard.

At their June 12-17, 2006 Council Meeting in Miami, Florida the Council approved Snapper Grouper Amendment 14 for public hearing. Council may want to consider designating as marine reserves. As a part of this scoping process, the Marine Reserves Advisory Panel was asked to also suggest areas. As a result of this process over 40 sites were suggested and originally considered as potential marine reserves.

8.1.2 National Marine Sanctuaries

The National Marine Sanctuary Program (NMSP) is responsible for identifying, designating, and managing ocean and Great Lake areas of special national significance as national marine sanctuaries. Sanctuaries are managed to protect and conserve their resources and to allow uses that are compatible with resource protection. Management of sanctuaries is composed of a number of components:

- authorizing legislation (National Marine Sanctuaries Act - NMSA);
- regulations;
- management plans;
- management effectiveness programs;
- permitting;
- conservation policy; and
- strategic planning.

Legislation

The NMSA authorizes the existence of the NMSP, describes the purposes and policies of the NMSP, and provides authorization for appropriations. The NMSA is reauthorized every four to five years, allowing for updating and adaptation as necessary. While the NMSA provides the basis for everything else that follows, the NMSP must also develop regulations, management plans, policies, and operational procedures.

Regulations
Regulations represent the detailed implementation of the NMSA in the protection and conservation of sanctuary resources. Upon designation of a sanctuary or during a management plan review, site-specific regulations are issued that restrict a narrow range of activities, because an activity has already been found to be incompatible with the primary mandate of resource protection or is a proactive step necessary for the protection of a specific resource. The NMSP can also revise existing regulations or issue new regulations after the designation of a site. This may occur after a sanctuary has been in operation for several years and either a new activity is identified that did not exist prior to the sanctuary's designation, or new information about an existing activity reveals it is incompatible with resource protection or is resulting in user conflict. Under certain circumstances, the NMSP can also issue emergency regulations. Although the NMSP would generally seek non-regulatory means to address an issue, circumstances may warrant the issuance of a new regulation.

Management Plans
Management plans are site-specific documents that the NMSP uses to manage individual sanctuaries. Management plans:

- summarize existing programs and regulations;
- guide preparation of annual operating plans;
- articulate visions, goals, objectives, and priorities;
- guide management decisionmaking;
- guide future project planning;
- ensure public involvement in management processes; and
- contribute to the attainment of system goals and objectives.

The NMSP has begun a comprehensive process that will lead to the review and possible revision of management plans at all 13 Sanctuaries. Reviews of management plans have been undertaken because:

- most existing management plans are 10 years old or older and evolving issues may not be adequately addressed;
- most existing management plans do not incorporate state-of-the-art concepts and practices associated with management of marine protected areas; and
- the NMSA has a statutory requirement that management plans should be reviewed on a periodic basis.

Management Effectiveness
Assessing management effectiveness (the achievement of a planned effort or action) is a critical element of the management of sanctuaries, and is done both internally by the NMSP and by external sources. It is part of routine sanctuary management efforts in order to foster a feedback loop that encourages an internal approach to problem solving and improved performance.

Internal Performance Evaluation

The NMSP has developed a suite of "program performance measures" to measure progress on several representative functions of the program dictated by the mandate of the National Marine Sanctuaries Act. Each sanctuary undergoing management plan review also develops site-specific performance measures that measure progress toward the goals and objectives of the individual sanctuary.

Performance evaluation contributes to the overall management process by:

- fostering the development of clear, concise problem statements and measurable outcomes;
- providing a tool that allows managers to comprehensively evaluate their sites in both the short and long term;
- allowing site staff to make decisions based on more accurate and relevant information;
- promoting accountability;
- supporting sanctuary efforts with an informed resource-allocation process; and
- motivating staff with clear policies and a focused direction.

Program performance measures are reported on and reviewed annually. The result of that effort is used in the internal resource-allocating process as a means to inform NMSP leadership on performance-based priorities.

External Evaluations on Management Effectiveness
Every few years, the NMSP commissions an external evaluation by an independent organization in order to obtain fresh insights, and to assess and support programmatic improvements in the broad operation of the NMSP. External evaluations work to help assess, adjust, and guide the NMSP. Five independent, external evaluations have been conducted on the NMSP since passage of the NMSA in 1972: the General Accounting Office in 1981, an External Review Team in 1993, the National Research Council (NRC) in 1997, and the National Academy of Public Administration in 2000 and 2006.

In 2004, the NMSP also completed the Program Assessment Rating Tool (PART), a government-wide performance evaluation process implemented by the Office of Management and Budget (OMB). The PART's primary function is to determine whether federal programs are meeting the mandated requirements identified for them in their enabling legislation and if mechanisms are in place to track their progress in doing so (namely, performance measures). The NMSP was "PARTed" with the Marine Protected Area Center (MPAC) under the rubric "NOAA Protected Areas Program." The NMSP will be "PARTed" again in the near future, following OMB's schedule for reviewing all federal agencies.

Permits
The NMSP has the authority to issue permits to allow some types of activities that are otherwise prohibited by sanctuary regulations, but which generally present a public benefit by furthering the management and protection of sanctuary resources. Permits

usually include conditions that are designed to minimize or eliminate impacts to sanctuary resources. Permit conditions may also be included to minimize user conflict.

Conservation Policy
The NMSP conducts policy planning to provide a framework for the development of policies at both the national (system-wide) and individual sanctuary level. While this proactive approach to resource management is best, in reality most policies are developed in response to something that has already become a problem. The simple scale of some issues may seem prohibitive (e.g., invasive species), while in other cases the newness of an issue makes response difficult since little information may be available about its impacts (e.g., alternative energy). Policies are often used not only to address issues by themselves, but they also provide guidance in the use of other management tools, such as marine zoning, permits, and regulations. Sites should, for complex issues or those with broad national implications, work within the guidelines of national policies that have been or are being developed.

Strategic Planning
Since 2004, the National Marine Sanctuary Program has invested a great deal of staff time and effort in developing and implementing a comprehensive and efficient program planning, execution, and reporting system. This system is coordinated by the Senior Policy Advisor for Strategic Planning and Program Integration and the NMSP Strategic Planning Team (SPT), which has representatives from all HQ units, regions, and cross cutting programs across the NMSP. Although originally established to institutionalize the annual operating plan process and the structure and operations that support it, the overall purpose of the SPT now is to facilitate the NMSP strategic planning process and provide information on areas of subject matter expertise, while thinking about innovative ways to better integrate operations of the NMSP. Specifically, the SPT focused in three areas:

1) NMSP planning and operations -- refining the NMSP AOP process, schedule and components

2) Agency-level budget and administrative requirements – integrating NMSP activities and requirements within the Coastal and Marine Resource Program (CMRP), Ecosystem Goal Team, and other NOAA matrix/goal teams.

3) Emerging opportunities – responding to high priority activities or issues that must be addressed due to high visibility or public expectations.

8.1.2.1 Gray's Reef

Gray's Reef National Marine Sanctuary (GRNMS) started reviewing its existing management plan in 1999. As part of the process, the Sanctuary Advisory Council was formed in August 1999. By 2001, the council consisted of 11 members representing education, research, sport diving, sport fishing, conservation, and selected government agencies. Since then, additional members have been added to the council representing charter/commercial fishing and two governmental seats.

Once in place, the advisory council and sanctuary staff considered the original list of GRNMS goals and objectives from the 1983 plan, and modified them to be consistent with the most recent reauthorization of the National Marine Sanctuaries Act (2000), as well as contemporary issues.

The management plan review process also relied on active public participation. In addition to producing a revised plan, the process brought together diverse stakeholder interests and expertise to shape and support new program directions that address current priority resource issues and conservation objectives.

Eight public scoping meetings were held at which sanctuary users, members of the public and agencies identified issues and problems they said they thought GRNMS might be able to address. Approximately 2,000 people made comments on the draft plan. They expressed concerns and provided recommendations in person and via fax, telephone and email. The comments were incorporated into a summary report which was presented to the advisory council and distributed to all participants, the media, and other interested parties. Seven additional, separate public meetings were held to review the draft plan. The final GRNMS management plan is available at http://graysreef.noaa.gov/management.html

8.1.2.2 Florida Keys

The Florida Keys National Marine Sanctuary (FKNMS) was designated in accordance with the National Marine Sanctuaries Act (NMSA). Regulatory and enforcement powers of National Marine Sanctuaries are specified in the Act. The National Oceanic and Atmospheric Administration (NOAA) has been assigned responsibility for managing the nation's National Marine Sanctuaries and has developed regulations uniquely suited to protect the resources at each sanctuary. The primary regulations governing management of the FKNMS are described in the United States Code of Federal Regulations, Title 15, Part 922.

Ecological Reserves (ER's): Western Sambo and Tortugas. In addition to Sanctuary-wide regulations, special regulations have been set in place in these areas in order to protect resources.

Sanctuary Preservation Areas (SPA). There are 18 small SPAs that protect popular shallow coral reefs. In addition to Sanctuary-wide regulations, special regulations have been set in place in these areas in order to protect resources. Activities that will be prohibited in the Sanctuary Preservation Areas include spearfishing, shell collecting, tropical fish collecting, fishing and other activities that result in the harvest of marine life by divers, snorkelers, and fishermen. In addition, direct physical impact to corals in these areas is restricted.

Wildlife Management Areas (WMA). There are 27 WMA's. The majority of these areas (20) fall under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) and

Sanctuary regulations have been established to complement the existing USFWS management plan. Public access restrictions in these areas include idle speed only/no wake, no access buffer, no motor, and limited closures.

Existing Management Areas (EMA). Sanctuary regulations have been established to complement those in existing management areas, including Looe Key and Key Largo Management Areas as well as the Great White Heron and Key West National Wildlife Refuges, and all the State Parks and Aquatic Preserves.

Special Use Areas. There are four areas designated: Conch Reef, Tennessee Reef, Looe Key (patch reef), and Eastern Sambo Reef. These are all designated as research-only areas. No person may enter these areas except as specifically authorized by a valid permit.

The FKNMS Management Plan is available at http://floridakeys.noaa.gov/regs/welcome.html

8.1.2.3 Monitor

Management of the Monitor National Marine Sanctuary is composed of a number of components including authorizing legislation, regulations, management plans and permitting. Management plans are site-specific documents that the NMSP uses to manage individual sanctuaries. Sanctuaries are managed to protect and conserve their resources and to allow uses that are compatible with resource protection. The public management plan review process will begin for the Monitor NMS in 2008.

8.1.3 Minerals Management Service

8.1.3.1 OCS Leasing

(from MMS website: http://www.mms.gov/5-year/2007-2012main.htm#Proposed_Program)
The OCS Lands Act requires the Department of the Interior (DOI) to prepare a 5-year program that specifies the size, timing and location of areas to be assessed for Federal offshore natural gas and oil leasing. It is the role of DOI to ensure that the U.S. government receives fair market value for acreage made available for leasing and that any oil and gas activities conserve resources, operate safely, and take maximum steps to protect the environment.

OCS oil and gas lease sales are held on an area-wide basis with annual sales in the Central and Western Gulf of Mexico with less frequent sales held in the Eastern Gulf of Mexico and offshore Alaska. The program operates along all the coasts of the United States - with oil and gas production occurring on the Gulf of Mexico, Pacific and Alaska OCS. The MMS is also responsible for other mineral production offshore, which currently includes using sand and gravel for coastal restoration projects.

The following planning areas are still subject to a 1998 Presidential withdrawal from leasing through June 30, 2012, under the authority of Section 12 of the OCS Lands Act (43 USC 1341). All but North Aleutian Basin, Alaska, are also subject to annual Congressional moratoria, some from as early as Fiscal Year (FY) 1982:

- Washington-Oregon
- Northern, Central and Southern California
- Eastern Gulf of Mexico, except for the portion located off Alabama and morethan 100 miles off Florida that was proposed, but not offered, for Lease Sale181 in 2001
- South, Mid and North Atlantic

In addition, in 1998 President Clinton withdrew indefinitely all National Marine Sanctuaries.

The first Congressional moratorium was enacted in FY 1982, prohibiting leasing off the Central and Northern California coast. In 1984, Southern California, the North Atlantic, and part of the Eastern Gulf Of Mexico, basically south of the 26 degree N latitude, were subject to moratoria. In FY 1990, the North Aleutian Basin, Alaska, and the Mid-Atlantic became moratoria areas. Washington/Oregon and the Florida Panhandle area of the Easter Gulf of Mexico were added to the moratoria list in FY 1991. The South Atlantic was added in 1992. These areas have been continued to be subject to annual congressional moratoria, with the exception of the North Aleutian Basin, Alaska, which has not been included since FY 2004.

8.1.4 Environmental Protection Agency

8.1.4.1 ODMDSs

In 1972, Congress enacted the Marine Protection, Research, and Sanctuaries Act (MPRSA) to prohibit the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment. The MPRSA, also known as the Ocean Dumping Act, implements the requirements of the London Convention, which is the international treaty governing ocean dumping.

Virtually all material dumped in the oceans off the United States today is dredged material. Other materials that are currently ocean-disposed include fish wastes, human remains, and vessels. Certain materials, such as high-level radioactive waste, medical waste, sewage sludge, and industrial waste, may not be dumped in the ocean.

Ocean dumping cannot occur unless a permit is issued under the MPRSA. In the case of dredged material, the decision to issue a permit is made by the U.S. Army Corps of Engineers (COE), using the Environmental Protection Agency's (EPA) environmental criteria and subject to EPA's concurrence. For all other materials, EPA is the permitting agency. EPA is also responsible for designating recommended ocean dumping sites for all types of materials (http://www.epa.gov/Region4/water/oceans/).

Site Selection of ODMDS's

Twenty-one commercial ports and four military ports are located within EPA Region 4. Millions of cubic yards of sediments are dredged from these ports each year, much of which is disposed in the ocean off the southeastern United States. Regulation of dredged material disposal within ocean waters in the Southeast is a shared responsibility of EPA Region 4 and the COE South Atlantic Division. Under the MPRSA, the COE is the permitting authority for the proposed disposal of dredged material. Permits for ocean disposal of dredged material are subject to EPA review and concurrence. EPA is also responsible for designating and managing ocean disposal sites for dredged material.

Most of the dredged material disposed in the ocean is disposed at ocean dumping sites specifically designated by EPA for dredged material disposal under section 102 of the Marine Protection, Research, and Sanctuaries Act (MPRSA). EPA designated sites are to be used for ocean disposal to the extent feasible.

All ocean dumping sites (Figure 1) are required to have a site management and monitoring plan (SMMP). Appropriate management of ocean dumping sites is aimed at assuring that disposal activities will not unreasonably degrade or endanger human health, welfare, the marine environment or economic potentialities.

Management of ocean dredged material disposal sites involves:

1. Regulating the times, the quantity, and the physical/chemical characteristics of dredged material that is dumped at the site;
2. establishing disposal controls, conditions, and requirements to avoid and minimize potential impacts to the marine environment; and
3. monitoring the site environs to verify that unanticipated or significant adverse effects are not occurring from past or continued use of the disposal site and that permit terms are met.

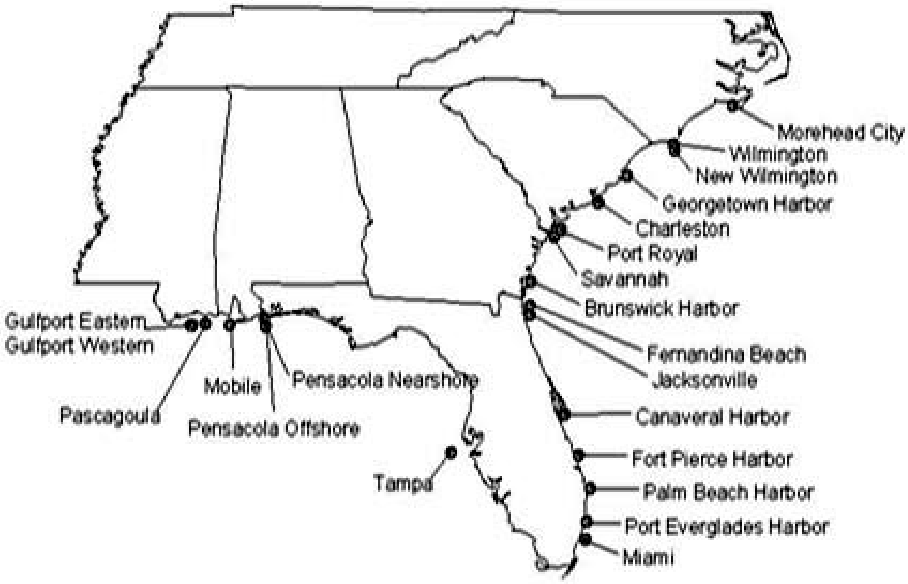

Figure 8.1-1. Disposal sites in the Southeast
(http://www.epa.gov/Region4/water/oceans/sites.html).

Permitting Procedures
Marine Protection, Research and Sanctuaries Act (MPRSA) Section 103 permits for the ocean dumping of dredged materials are issued by the Corps of Engineers (COE) subject to EPA approval. The COE District office is responsible for coordination of all federal actions, including EPA concurrences, pertaining to MPRSA Section 103 applications. All applications should be coordinated with EPA Region 4. Applicants are encouraged to arrange for a pre-application conference with the District and EPA in order to fully understand the process and requirements for obtaining the permit. EPA will not approve the permit unless the proposed dredged material has been shown to meet the ocean dumping criteria. Data requirements for ensuring this compliance can be extensive and the permitting process typically takes from 6 to 18 months (http://www.epa.gov/Region4/water/oceans/).

The permit process is outlined below and consists of 10 main steps:
Pre-application Consultation: Includes discussion of alternatives and the information required for use in evaluating the proposed dredged material.

Evaluation of Dredged Material Proposed for Ocean Disposal: Includes development, approval and implementation of a sampling and analysis plan and an assessment of compliance with the ocean dumping criteria.

Permit Application: Title 33 Code of Federal Regulations Part 325.1 (33 CFR 325.1) describes the requirements of the permit application. In addition, the application should include:

a. An evaluation of dredged material disposal alternatives including an examination of potential beneficial uses of the proposed dredged material.
b. Written documentation of the site dredging history and a general survey of other prior or current dredging activities at or near the site.
c. References to existing or prior MPRSA Section 103 permits.

Review of Application for Completeness: Additional information is requested if the application is incomplete.

Issuance of Public Notice by District: Public Notices must include all of the information required in 33 CFR 325.3(a)

EPA Review: EPA has 45 days with an optional additional 45 day extension to review the information and to determine compliance with the ocean dumping criteria. If additional information is needed, EPA has 30 days to request that information.

District Engineer Completes Evaluation: The COE addresses comments and holds a public meeting if needed.

Public Interest Review: The COE considers all comments and incorporate them into the administrative record of the application.

Permit Issued: A decision to issue or deny a permit is discussed in either a Statement of Findings or Record of Decision and the permit is issued.

Permit Public Notice: A list of permit decisions is published.

Evaluation of dredged material for ocean disposal under the MPRSA relies largely on biological (bioassay) tests. The ocean testing manual, commonly referred to as the Green Book, provides national guidance for determining the suitability of dredged material for ocean disposal. Regional guidance is provided in the EPA Region 4 - U.S. Army Corps of Engineers South Atlantic Division Regional Implementation Manual PDF (RIM) (http://www.epa.gov/Region4/water/oceans/).

The Green Book sets out a framework containing the procedures approved by EPA and the Corps for evaluating the dredged material. The framework provides that the intensity of evaluation increases with the risk of contaminants and/or absence of existing information. If an evaluation in one level (tier) is not adequate to determine the material's suitability for ocean disposal, the evaluation proceeds to the next tier(s), and the protocols of the next tier(s) must be followed (Appendix K, SAFMC 1998a).

The following is a general summary of the testing and evaluation procedures included in each tier:

Tier I - Evaluation of Existing Information

Tier I specifies when and how existing information, such as results from previous tests on the material, can be used to evaluate the material. If the existing information is inadequate, the evaluation must go to the next tier(s).

Tier II - Conservative Screening Tools

Tier II specifies when and how sediment chemistry can be used in evaluating material by using worst case water column modeling and Theoretical Bioaccumulation Potential (TBP) calculations for the dredged material. (Because there is no model for evaluating toxicity, all sediments entering Tier II must also be tested for toxicity in Tier III.)

The 1991 manual includes updated scientific models for evaluating compliance with water quality criteria issued by EPA to help protect marine species. The dumping must meet the applicable water quality criteria. The 1991 manual includes use of TBP, which is a scientifically valid approach for evaluating the potential bioaccumulation of certain specific, non-ionic compounds (such as PCBs and dioxin). There is no counterpart model available for metals or polar compounds so if their presence is a concern, actual bioaccumulation testing in Tier III is still necessary.

Tier III - Laboratory Bioassays

Tier III specifies approved testing procedures for toxicity and bioaccumulation. The acute toxicity tests employ 10 day exposures. The 1991 manual stresses the use of amphipods, which are sensitive bottom-dwelling organisms, and describes standardized test methods that were not available when the 1977 manual was developed.

The bioaccumulation tests employ 28 day exposures if contaminants with the potential to bioaccumulate are present in the material. The 1977 manual specified 10 day exposures for all compounds. Use of 28 day exposures to assess bioaccumulation of contaminants was found to be more appropriate.

Tier IV - Advanced Biological Evaluations

Tier IV consists of laboratory and field tests and other evaluations to reduce specific uncertainties about the potential impacts of proposed projects. Tests conducted under this tier are not considered routine in the regulatory program, and can require significant time and expense.

The Green Book includes evaluation methods which can be tailored to the material and location. This is intended to ensure that material is adequately evaluated to make a scientifically sound decision regarding the potential environmental impacts of the proposed ocean dumping, without requiring unnecessary or inappropriate tests in any given case.

Corps Districts and EPA Regional offices work together to develop Regional Implementation Manuals providing supplemental site-specific refinements to the national guidance, such as: identifying the contaminants of concern for the harbors within the region; and identifying the specific species of organisms to be tested (from the list of organisms in the national manual). Testing procedures used to evaluate ocean dumping must be approved by EPA and the Corps. No permit is issued unless the agencies have enough information to determine that the ocean dumping will not cause significant harmful effects. (Appendix K, SAFMC 1998a)

8.1.5.2 National Estuary Program

As part of the 1987 amendments to the Clean Water Act, Section 320 National Estuary Program (NEP) promotes comprehensive planning efforts to help protect nationally significant estuaries in the United States that are deemed to be threatened by pollution, development, or overuse. Since the inception of the program, 28 estuaries have been nominated by their respective state Governors and officially designated as NEP estuaries (National Estuary Program Coastal Condition Report, Executive Summary, June 2007). As one of the U.S. EPA most successful watershed programs, the NEP demonstrates the effectiveness of a stakeholder-driven, collaborative process to address water quality problems and to target habitat restoration. Individual NEPs are required to monitor the effectiveness of their management activities to address estuary-specific priority actions. The Clean Water Act also requires that EPA report periodically on the condition of the nation’s estuarine waters. Coastal states provide EPA with valuable information about the condition of their estuarine resources; however, because the individual states, the NEPs, and their partners use different approaches for data collection and the evaluation of estuarine condition, it has been difficult to compare this information among states, NEPs, or on a regional or national basis (National Estuary Program Coastal Condition Report, Executive Summary, June 2007).

The purpose of the NEP is to identify, restore, and protect the nationally significant estuaries of the United States. The Southeast coast is home to two NEP estuaries: the Albemarle-Pamlico Estuarine Complex and the Indian River Lagoon (National Estuary Program Coastal Condition Report, Chapter 4: Southeast National Estuary Program Coastal Condition, June 2007).

Albemarle-Pamlico National Estuary Program (APNEP)
The Albemarle-Pamlico Estuarine Complex drains approximately 30,000 mi^2 of watershed and comprises the largest lagoonal estuarine system in the United States. This NEP has a 23,000-mi^2 study area that extends south from Prince George County, VA, to Carteret County, NC, and includes 7 sounds (Albemarle, Bogue, Core, Croatan, Currituck, Pamlico, and Roanoke) (APNEP, 2006) (National Estuary Program Coastal Condition Report, Chapter 4: Southeast National Estuary Program Coastal Condition, Albemarle-Pamlico National Estuary Program, June 2007).

The Albemarle-Pamlico Estuarine Complex NEP study area contains large tracts of forested and undeveloped land, including 11 National Wildlife Refuges (e.g., Great Dismal Swamp, Back Bay, Mackay Island, Currituck, Roanoke River, Alligator River, Pocosin Lakes, Pea Island, Mattamuskeet, Swan Quarter, and Cedar Islands). The Complex’s watershed also contains the Cape Lookout and Cape Hatteras National Seashores; the Croatan National Forest; and many state-owned parks, forests, and research reserves (Martin et al., 1996). In addition, several U.S. Department of Defense (DoD) lands are located in this watershed.

Freshwater inputs to this system are provided by five major rivers — the Pasquotank, Chowan, and Roanoke rivers that flow into Albemarle Sound and the Tar-Pamlico and Neuse rivers that flow into Pamlico Sound. This region features a variety of habitat types, including significant pocosins (southeastern shrub bogs), pine savannahs, hardwood swamp forests, bald cypress swamps, salt marshes, brackish marshes, freshwater marshes, and beds of submerged aquatic vegetation (SAV) (Martin et al., 1996).
On the eastern side of the Albemarle-Pamlico Estuarine Complex, a chain of islands forms a barrier with the Atlantic Ocean. The Complex is uniquely characterized by random wind-driven tides, which result in less predictable variations in water circulation and salinity patterns (Focazio, 2006a). Economically, this estuarine system represents the Southeast region's key resource base for commercial fishing, tourism, recreation, and resort development. Economic benefits are also derived from the use of the area's natural resources for mining, forestry, and agriculture (APNEP, 2006).

The Albemarle-Pamlico National Estuary Program (APNEP) was among the first NEPs established by EPA in 1987. Its overall condition is good to fair based on the four indices of estuarine condition used by the NCA (National Coastal Assessment). The water quality index for the Complex is rated good, the sediment quality and fish tissue contaminants indices are rated good to fair, and the benthic index is rated fair. However, factors such as chlorophyll a, dissolved oxygen, and sediment quality may signal declining health, especially in some tributary river areas.

The APNEP continues to work toward fulfilling its goals and has already seen some major accomplishments, including the following:

- Restoration of more than 1,100 miles of anadromous fish habitat through the removal of three dams.
- Enhancement of interagency and interstate coordination through creation of the APNEP.
- Organizational restructuring to promote region-wide interstate citizen involvement through collaboration and coordination.
- Development of bycatch reduction gear (e.g., sea turtle exclusion devices) and practices to reduce fisheries impacts.
- Restoration of two miles of riparian habitat along the Roanoke River through livestock fencing and riverbank-stabilization practices (APNEP, 2006).

Indian River Lagoon National Estuary Program
The Indian River Lagoon is located along Florida's east coast and stretches 156 miles from Volusia County to Palm Beach County, FL. This area comprises one of the most diverse estuaries in North America and one of Florida's most popular fishing destinations, with more than 1 million anglers visiting the Lagoon area each year (U.S. EPA, 2000c). The Lagoon and its surrounding watershed include a wide variety of habitats that support a diverse assemblage of plants and animals (SJRWMD, 2004).

These habitats range from xeric scrub through pine flatwoods, tropical and temperate hardwood hammocks, salt marshes, mangrove swamps, and other intertidal communities such as seagrass meadows and other SAV communities (Hill, 2002) (National Estuary Program Coastal Condition Report, Chapter 4: Southeast National Estuary Program Coastal Condition, Indian River Lagoon National Estuary Program, June 2007).

This region’s broad diversity of habitats support more than 4,300 different species, including 700 saltwater and freshwater fish species and 310 bird species (SJRWMD, 2004). Thirty-six of the species found in this region are classified as threatened or endangered, including the Southeastern beach mouse, Atlantic saltmarsh snake, bald eagle, and Florida scrub jay (SJRWMD, 2004; U.S. EPA, 2006d). In addition, an estimated one-third of Florida’s endangered West Indian manatees live in the Indian River Lagoon.

Commercially, the estuary is one of the most important waterways in Florida and is a productive nursery ground for an estimated $300 million in annual commercial fishing revenues, including $100 million from inshore species. The Indian River Lagoon accounts for 50% of Florida’s total East Coast fisheries landings (SJRWMD, 1994). Also, tourism and recreation contribute $540 million to the local economy, and the influx of tourists and part-time residents to the area is considerable (SJRWMD, 2002).

In 1987, the Florida Legislature passed the Surface Water Improvement and Management (SWIM) Act, which designated the Indian River Lagoon as a priority water body in need of restoration and special protection (Florida Statutes, Chapter 373.451–373.4595). Created in 1990, the Indian River Lagoon NEP (IRLNEP) fosters active participation by other federal agencies, notably the FWS, NASA, and USACE. It also manages a local government cost-share program that assists counties and municipalities with planning and implementing pollution-abatement projects, typically small-scale efforts with an emphasis on stormwater treatment. For instance, both the St. John’s River Water Management District (SJRWMD) and South Florida Water Management District (SFWMD) focus on projects designed to improve water and sediment quality, restore or enhance the seagrass community in the Lagoon, or rehabilitate wetlands, recovering many of the natural functions of these areas.

The overall condition of the Indian River Lagoon is rated good based on three of four indices of estuarine condition used by the NCA. The water quality, sediment quality, and benthic indices were each rated good for the Indian River Lagoon, and data was unavailable to calculate the fish tissue contaminants index for this estuary.

The greatest tangible improvement to date in the Indian River Lagoon is the hydrologic reconnection of more than 23,000 acres of impounded wetlands since 1989 under the SWIM Act (in addition to nearly 5,000 acres reconnected through other programs). These impoundment reconnections restore many natural functions provided by salt marshes and mangrove wetlands (Steward et al., 2003).

There is also a noticeable increase in public awareness of the Lagoon's problems and its ecology, as well as an understanding of the projects that are underway to benefit the Lagoon's recovery and management. Much has been accomplished, but the IRLNEP recognizes that more work remains to be done to reach restoration targets established for seagrass and coastal wetlands. Preventative safeguards, vigilance, and education are needed to ensure that achievements in addressing problems in the Indian River Lagoon are maintained and that progress continues in protecting and restoring the water quality and natural resources of the Lagoon (Steward et al., 2003).

There is also progress taking place within the Indian River Lagoon watershed. More than 56,000 acres of wetlands and uplands have been acquired for various purposes (such as water quality remediation projects and habitat preservation). The various agencies and local governments with jurisdiction over the Indian River Lagoon basin have made advancements in ending discharges of treated wastewater, removing harmful muck deposits, and making incremental improvements in stormwater management throughout the basin.

In recent years, the IRLNEP has tackled some of the most important and controversial issues to address pollution in the Indian River Lagoon basin including addressing the impact of septic tanks on water quality, promoting the acquisition of environmentally sensitive lands, promoting the development of regional stormwater management plans, and participating in the development of local management plans for threatened and endangered species.

Some of the ongoing goals of the IRLNEP include:

- Attaining and maintaining water and sediment of sufficient quality to support a healthy, macrophyte-based estuarine Lagoon ecosystem.
- Attaining and maintaining a functioning macrophyte-based ecosystem that supports endangered and threatened species, fisheries, and wildlife.
- Improving the understanding and management of impacts of invasive and exotic species and the emerging challenges to aquatic animal health.
- Achieving heightened public awareness and coordinated interagency management of the Indian River Lagoon ecosystem (Steward et al., 2003).

Based on data collected by the NCA, the overall condition of the Indian River Lagoon is rated good. In general, the IRLNEP considers seagrass coverage in the Indian River Lagoon to be a key indicator of trends in environmental condition. Areas with good seagrass coverage are located adjacent to fairly undeveloped watersheds or close to inlets, whereas areas of extensive SAV loss and sparse seagrass are adjacent to highly developed watersheds or shoreline areas. The areas with poorest water quality are Cocoa to Melbourne/Palm Bay, the southern Banana River, and the Vero Beach, Fort Pierce, and St. Lucie River areas. Areas of the Indian River Lagoon adjacent to larger tributaries and major drainages systems experience elevated levels of nutrients and total suspended solids.

(All cited references found in National Estuary Program Coastal Condition Report, Appendix & Back Cover, June 2007)

8.1.6 National Estuarine Research Reserves

(Information from the NERR web pages http://www.nerrs.noaa.gov/welcome.html)
The National Estuarine Research Reserves System is a network of 27 areas representing different biogeographic regions of the United States that are protected for long-term research, water-quality monitoring, education and coastal stewardship. Established by the Coastal Zone Management Act of 1972, as amended, the reserve system is a partnership program between the National Oceanic and Atmospheric Administration and the coastal states. NOAA provides funding, national guidance and technical assistance. Each reserve is managed on daily basis by a lead state agency or university, with input from local partners.

North Carolina
In North Carolina the reserve is comprised of 10,000 acres in four sites located near Corolla (Currituck Banks), Beaufort (Rachel Carson) and Wilmington (Masonboro Island and Zeke's Island).

The North Carolina National Estuarine Research Reserve encourages researchers from universities and government laboratories to use the four sites for short or long-term investigations that will promote better understanding and management of estuaries. Data from monitoring stations, an annotated bibliography of work done on each site, species lists and GIS maps are offered to participating investigators. Projects have been completed on such diverse topics as estuarine eutrophication, productivity of benthic microalgae, use of dredge material to renourish salt mashes and effects of feral horses on salt marsh productivity.

The Graduate Fellows Program of the National Estuarine Research Reserve System fosters graduate student use of the reserves for their research projects. Fellows then contribute to other current reserve programs.

The research office initiates and conducts research into the dynamics of estuaries. Two ongoing projects are: 1) a Habitat Assessment Tool that can gather water quality data for a large body of water by the use of a towed instrument and 2) the National Telemetry Project that will provide real-time weather and water quality data accessibility throughout the National Estuarine Research Reserve System.

South Carolina
The North Inlet-Winyah Bay reserve encompasses 12,327 acres located in Georgetown County, SC. The reserve features the salt marshes and ocean dominated tidal creeks of the North Inlet Estuary plus the brackish waters and marshes of the adjacent Winyah Bay Estuary. North Inlet is a relatively pristine system in which water and habitat quality are much higher than those in Winyah Bay. As the estuary with the third largest watershed on the east coast,Winyah Bay has been greatly influenced by agriculture, industry and other

human activities. More than 90 percent of North Inlet's watershed is in its natural forested state

The reserve is home to many threatened and endangered species, including sea turtles, sturgeons, least terns and wood storks.

Reserve resources range from tidal and transitional marshes to oyster reefs, beaches, and inter-tidal flats and from coastal island forests to open waterways.

More than 90 research and environmental monitoring projects involving more than 70 scientists are currently underway within the reserve. Long-term ecological data collections initiated more than 20 years ago continue to provide insights into patterns and mechanisms of both natural and human-related change in the estuaries. University based researchers use the System-wide Monitoring Program data to support field and laboratory studies, which range from the molecular to ecosystems level.

The Ashepoo-Combahee-Edisto (ACE) Basin reserve comprises134,710 acres located in Colleton, Charleston, Beaufort and Hampton counties. The ACE Basin is one of the largest undeveloped estuaries on the East Coast. The Ashepoo, Combahee and Edisto rivers, meander past cypress swamps, historic plantation homes, old rice fields and abundant tidal marshes to meet at South Carolina’s biologically rich St. Helena Sound.

The ACE Basin National Estuarine Research Reserve protects the natural beauty, abundant wildlife and unique cultural heritage of the area. In addition, the reserve preserves habitat for many endangered or threatened species, such as shortnose sturgeon, wood storks, loggerhead sea turtles and bald eagles.

Research conducted at the ACE Basin Reserve enhance the protection of these commercial and recreational uses by monitoring water quality, providing information on the abundance and types of important plant and animal species, and evaluating the overall health of the ACE Basin ecosystem.

Through a variety of educational programs, the reserve provides timely information to coastal decision makers, lawmakers, teachers, students and the general public. The reserve sponsors a summer lecture series, develops curriculum materials for teachers, offers a touch tank program for children and conducts educational cruises where students and teachers learn about estuaries and their values to marine life.

Georgia

The Sapelo Island National Estuarine Research Reserve, comprising 6,110 acres, is a coastal plain estuary, protected on its seaward side by a Pleistocene barrier island.

Sapelo Island is the fourth largest Georgia barrier island and one of the most pristine. The reserve is made up of salt marshes, maritime forests and beach dune areas. Not only is the island rich in natural history, but also in human history dating back 4,000 years.

The Sapelo Island Reserve habitats include a sand-sharing system comprised of shoreface, foreshore, backshore and dune components; an extensive band of salt marsh (comprising two-thirds of the reserve) and some 2,300 acres of upland forest, dominated by stands of oak hardwoods and pines.

Florida

The Guana Tolomato Matanzas National Estuarine Research Reserve encompasses approximately 55,000 acres of salt marsh and mangrove tidal wetlands, oyster bars, estuarine lagoons, upland habitat and offshore seas in Northeast Florida. It contains the northern most extent of mangrove habitat on the east coast of the United States.

The coastal waters of the GTM Reserve are important calving grounds for the endangered Right Whales. Manatees, wood Storks, roseate spoonbills, bald eagles and peregrine falcons also find refuge in the reserve.

The reserve is geographically separated into a northern section where the Tolomato and Guana rivers mix with the waters of the Atlantic Ocean, and a southern section along the Matanzas River, extending from Moses Creek south of Pellicer Creek. The unique Matanzas Inlet is one of the last natural, unaltered inlets on Florida's Atlantic coast.

The GTM estuary is rich with scenic beauty and economic value as it produces or supports the vast majority of the commercially and recreationally valuable fish and shellfish found in the region. The submerged lands, marshes, islands and conservation lands provide important habitat for a diversity of plants and animals, including the migrating birds stopping along the Atlantic Coastal Flyway.

Data generated from the research programs are used to assess the health of the ecosystem and guide future research efforts.

Visiting scientists utilize on-site field station for systems and baseline studies of the plant and animal communities of the reserve.

Long-term ecological monitoring efforts of the GTM Reserve include water quality monitoring (physical, chemical and biological), and meteorological and tidal conditions.

Geographic Information System (GIS) data and remote sensing are used to analyze natural resources within the reserve and human use of the coastal area.