FINAL

AMENDMENT #11 to the NORTHEAST MULTISPECIES FISHERY MANAGEMENT PLAN

AMENDMENT #9 to the ATLANTIC SEA SCALLOP FISHERY MANAGEMENT PLAN

AMENDMENT #1 to the MONKFISH FISHERY MANAGEMENT PLAN

AMENDMENT #1 to the ATLANTIC SALMON FISHERY MANAGEMENT PLAN

COMPONENTS of the PROPOSED ATLANTIC HERRING FISHERY MANAGEMENT PLAN

FOR

ESSENTIAL FISH HABITAT

incorporating the

ENVIRONMENTAL ASSESSMENT

VOLUME I

Prepared by

New England Fishery Management Council

in consultation with

National Marine Fisheries Service

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1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act, known as the Sustainable Fisheries Act (SFA), emphasized the importance of habitat protection to healthy fisheries and strengthened the ability of the National Marine Fisheries Service (NMFS) and the Councils to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed "essential fish habitat" (EFH) and is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

To improve fish habitat protection, the SFA requires or authorizes that the Councils, NMFS, and other federal agencies take new actions. The SFA required the Council, after receiving recommendations from NMFS, to amend its fishery management plans by October 1998 to:

- describe and identify the essential habitat for the species managed by the Council
- minimize to the extent practicable adverse effects on EFH caused by fishing
- identify other actions to encourage the conservation and enhancement of EFH

The purpose of the amendment is to identify and describe the EFH for Atlantic herring, sea scallops, Atlantic salmon, and fifteen species of groundfish managed by the Council to better protect, conserve, and enhance this habitat. This amendment also will identify the major threats to essential fish habitat from both fishing and non-fishing related activities and identify conservation and enhancement measures. In support of the Council’s habitat policy, the management objectives for the EFH amendment will be:

1. To the maximum extent possible, to identify and describe all essential fish habitat for those species of finfish and mollusks managed by the Council;
2. To identify all major threats (fishing and non-fishing related) to the essential fish habitat of those species managed by the Council; and,
3. To identify existing and potential mechanisms to protect, conserve and enhance the essential fish habitat of those species managed by the Council, to the extent practicable.

This amendment package amends all existing Council FMPs, including the Monkfish FMP, the Sea Scallop FMP, the Northeast Multispecies FMP, and the Atlantic Salmon FMP. This amendment package also includes components of the proposed Atlantic Herring FMP to address the required EFH elements. The EFH information related to Atlantic herring and contained herein will be incorporated by reference into the Atlantic Herring FMP. The Council had the option to submit separate EFH amendments to each of its FMPs, or to incorporate the EFH components into the FMP amendments addressing the other SFA requirements. The Council considered these options and determined that a single, omnibus EFH amendment was the most efficient and appropriate mechanism. This option eliminates unnecessary duplication (for instance, including the Non-Fishing Related Threats assessment in multiple FMP amendments), and allowed the Council to
take a more "ecosystem-based" approach in the development of the amendment. In the future, any FMP amendments or new FMPs will include EFH provisions directly within the parent documents. It is important to remember that this is but the first step in the process, and the Council will review and modify, as necessary, the EFH designations, as well as the other provisions of the EFH amendment.

The EFH amendment focuses on three major, distinct geographic regions – the Gulf of Maine, Georges Bank, and the portions of the continental shelf south of New England. The topographic and oceanographic features of each region are distinct and support diverse biological communities. The diverse habitat conditions, oceanographic processes, and biological composition in New England waters form some of the most productive fishing grounds in the world.

1.2 DESCRIPTION AND IDENTIFICATION OF ESSENTIAL FISH HABITAT

The regulatory text of the Interim Final Rule (Federal Register Vol. 62 No. 244, December 19, 1997) directs the Council to describe EFH in text and with tables that provide information on the biological requirements for each life history stage of the species. The text descriptions of essential fish habitat set the environmental parameters within which the map designations are considered. The tables summarize all available information on environmental and habitat variables that control or limit distribution, abundance, reproduction, growth, survival, and productivity of the managed species. The regulatory text of the Interim Final Rule also directs the Council to present the general distribution and geographic limits of EFH for each life history stage in the form of maps. The EFH maps are a means to visually present the EFH described in the amendment. The map designations of essential fish habitat identify the geographic extent within which certain types of habitat are considered EFH. EFH must be designated according to the following level of information available on the species distribution, abundance, and habitat-productivity relationships:

- Level 1: Presence/absence data are available for portions of the species' range.
- Level 2: Habitat-related densities are available.
- Level 3: Growth, reproduction, and survival rates within habitats are available.
- Level 4: Production rates by habitat are available.

There are several sources of distribution and abundance data used to develop the EFH designations. The NMFS bottom trawl survey (1963 - 1997) and the NMFS Marine Resources Monitoring, Assessment and Prediction (MARMAP) ichthyoplankton survey (1977 - 1987) provide the best available information on the distribution and relative abundance of Council-managed species in offshore waters. The bottom trawl survey is used for juveniles and adults, and the MARMAP survey is used for eggs and larvae. The Council used other sources of information on inshore areas, including the Massachusetts inshore trawl survey (1978 - 1997), information from Long Island Sound (1990 - 1996), and NOAA’s Estuarine Living Marine Resources (ELMR) program.

According to the language of the Interim Final Rule, EFH that is judged to be particularly
important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation, should be identified as "habitat areas of particular concern" (HAPC) to help provide additional focus for conservation efforts. Following a review of the scientific literature for information on areas deserving special attention or species with particular habitat associations, the Council has designated an area on Georges Bank as an HAPC for juvenile Atlantic cod. Considering the unique habitat associations and requirements of Atlantic salmon, the Council has designated the habitat of eleven rivers in Maine as HAPCs for Atlantic salmon. The Council may consider designating additional habitat areas of particular concern in the future. Additional designations may be based on existing or developing knowledge of species-habitat associations, the unique characteristics of a particular habitat type, the threats to sensitive habitats, or the importance of an area to multiple species.

For each species currently managed by the Council this amendment includes a one-page text description of the essential fish habitat for each life history stage, a table identifying those bays and estuaries included in the EFH designation (based on information provided in NOAA's ELMR reports), and a series of maps representing the Council's EFH designations for each life history stage. The EFH maps reflect all information included in the Council's designations, including the ELMR bays and estuaries, other inshore data, the historic range of the species, areas identified by the fishing industry, and those ten minute squares filled in to "smooth" the designations. The captions accompanying maps for the EFH designations describe the information reflected in those designations and provide the Council's rationale for selecting the preferred alternatives.

**1.3 FISHING-RELATED IMPACTS AND MANAGEMENT MEASURES**

The Council is required to identify and assess fishing activities that may adversely affect EFH. The effects of fishing, such as the direct effects of gear on seafloor habitats (e.g., direct removal of epifauna, smoothed bedforms) and the indirect effects of fishing (e.g., producing shifts in the benthic community because of initial removals of fauna), and other habitat related fishing activities that can be controlled by the Council are considered in this assessment. NMFS recommends that the assessment include, if known: a description of the mechanisms or processes of fishing gear causing adverse effects on habitat; the particular portion of EFH that is affected; a description of known or potential habitat functions disturbed or disrupted by these effects and the extent of such disturbance or disruption; options the Council will consider to minimize adverse effects from fishing practices; and mitigation measures to conserve and enhance EFH adversely affected by fishing activities, if appropriate.

There is very little information on impacts to habitat associated with several gear types used in the New England region, principally gillnets, longlines, haul seines, hand lines, mid-water trawls, purse seines, and stop seines. Gear types designed to work in mid-water do not impact the seafloor but may effect mid-water aggregations of gelatinous zooplankton which has been demonstrated to serve as habitat for some species. Other gear types which fish in a static fashion on the seafloor such as traps, gillnets and longlines are thought to minimally impact the seabed. However, the cumulative effects of static gear remain unknown. It is important to remember, however, that the impacts of
fishing gear depend not only on the type of gear used, but also the frequency and intensity of use, the type of bottom and the composition of the benthic community. Taking these considerations into account, the bottom-tending mobile gears (otter trawls, scallop dredges, beam trawls, and hydraulic clam dredges) are most likely to be associated with adverse impacts to habitat.

Based on a review of the National Marine Fisheries Service commercial fisheries landings data for the species managed by the New England Fishery Management Council, forty-three categories of fishing gear were identified as having been associated with landings during the fifteen-year period between 1982 and 1996. The three gear types that accounted for the top percentages of landings for each species were the otter trawl, scallop dredge, and purse seine. The otter trawl accounted for the majority of catch for all species except sea scallops and Atlantic herring.

Marine debris is on the increase in our region's waters, both inshore and offshore, as well as on our beaches. According to the Center for Marine Conservation, most debris in the Gulf of Maine comes from shore-based, non-fishing sources, although commercial fishing contributes about half of the debris found offshore. The principal debris for which the commercial fishing industry is responsible is lost fishing gear. Most studies on lost gear focus on the impacts to marine life rather than direct habitat impacts. Observations made during these studies appear to indicate that lost gear does not have a direct adverse impact on essential fish habitat.

Aquaculture may provide a substantial source of fresh finfish, shellfish, and seaweed to consumers, but it is potentially constrained by a variety of environmental issues associated with culture practices. Aquaculture production is rapidly expanding around the world, and the United States is beginning to follow the trend. There is particular interest in developing aquaculture in New England to supplement the historic capture fishery. The intensity and magnitude of threats to habitat differ between the types of aquaculture systems and the organisms cultivated. The development of aquaculture presents the following general threats; (1) discharge may contaminate water quality and benthos; (2) feed additives or exotic and reared species may alter natural ecosystems; and (3) habitat and biological association may be removed or changed with the construction of facilities. The potential threats may not be as severe as expected by scientists, media, and the general public. Some cases actually demonstrate that aquaculture development may promote healthier and more productive habitat conditions and positively influence marine resources. Management measures to directly regulate aquaculture facilities in federal and state waters are developing under the authority of several federal and state agencies. Research will assist the development of effective management strategies to stimulate the progress of the culture fishery.

Fish processing is an important component of fishing operations and economies of many New England fishing communities. Processing includes, but is not limited to, cleaning, cooking, canning, smoking, salting, drying, or freezing. Fish processing plants can be permanent, land-based or mobile, water-based operations. Commercial fisheries and aquaculture facilities require processing operations to produce high-quality, marketable
seafood. There are several environmental considerations associated with all types of fish processing plants. Treatment of fish processing effluent to reduce environmental impacts has become a matter of interest to many countries and fisheries.

The Council is required to prevent, mitigate, or minimize any adverse effect from fishing, to the extent practicable, if there is evidence that a fishing practice is having an identifiable adverse effect on EFH. Identifiable impacts are those supported by observable, negative effects on EFH quality or quantity. There are many issues and limitations associated with assessing adverse impacts to habitat from fishing activity, as well as many types of fishing gear and other fishing-related activities that may impact essential fish habitat. The Council also must give special consideration to gear types that will or could affect habitat areas of particular concern. Management measures currently in place protect and conserve essential fish habitat to varying degrees. Certain measures, such as the long-term closures of Closed Areas I and II and the Nantucket Lightship closure directly protect large areas encompassing many types of habitat, including the newly designated HAPC for juvenile Atlantic cod. Other measures, such as the days-at-sea program, indirectly protect and conserve essential fish habitat by controlling fishing effort. Any reduction of fishing effort will reduce the frequency and intensity with which fishing gear is used.

An understanding of the existing management measures that have the potential to either directly or indirectly protect EFH is important to the assessment of fishing-related threats to essential fish habitat (EFH). In order to determine which current management measures protect EFH, the Council performed an assessment of the habitat effects of all existing management measures. With the exception of the potential for impacts associated with effort displacement as a result of these measures, there are several existing management measures that directly protect EFH and others that indirectly protect EFH by reducing fishing effort. Immediately prior to the submission of this amendment to the Council's fishery management plans, the Council submitted separate amendments to each of its existing FMPs, as well as new FMPs addressing Atlantic sea herring and monkfish, to address the other provisions and requirements of the Sustainable Fisheries Act. The management measures adopted in these amendments and FMPs, in some cases, provide conservation benefits to the essential fish habitat designated in this amendment. In these cases, additional management measures implemented through this amendment would be redundant and unnecessary.

The existing framework adjustment procedures of the Northeast Multispecies, Sea Scallop, Atlantic Herring, Monkfish, and Atlantic Salmon fishery management plans will remain in effect with some modifications. The Council has developed framework adjustment language for inclusion in these FMPs so that habitat conservation management measures may be approved by the Council in a more timely manner than the plan amendment process. The Council also has developed framework adjustment language for inclusion in these FMPs so that the boundaries of the existing and all future essential fish habitat designations (including the designations of habitat areas of particular concern (HAPC)) may be modified in a more timely manner than the traditional plan amendment process.
1.4 NON-FISHING RELATED THREATS AND IMPACTS

The northwest Atlantic, including the Gulf of Maine, Georges Bank, and portions of the continental shelf south of New England (e.g. Nantucket Shoals), supports a number of commercial, recreational, and non-target finfish and shellfish. The variety of habitats found in New England aquatic and marine environments provide important habitat conditions for the reproduction, development, growth, feeding, and sustainability of fishery resources. The biological, chemical, and physical requirements of specific aquatic and marine organisms throughout their life history demonstrate the evolutionary adaptation to particular habitats for successful, healthy, and sustainable populations. Marine and aquatic organisms depend on riverine, inshore, and offshore habitats within the New England region. Habitat alteration and disturbance occurs from natural processes and human activities. Human-induced threats can have direct and indirect effects on finfish and shellfish populations, and subsequent long-term impacts on marine and aquatic resources. The major threats to marine and aquatic habitats are a result of increasing human population and coastal development which is contributing to an increase of human-generated pollutants entering the environment. These pollutants are discharged from a variety of non-point and point sources. Environmental conditions of finfish and shellfish habitat are also disrupted by human activities and direct habitat alteration.

1.5 CONSERVATION AND ENHANCEMENT MEASURES

The regulatory text of the Interim Final Rule directs the Council to describe options to avoid, minimize, or compensate for the adverse effects of activities identified in the non-fishing threats section of this amendment. The Council has the discretion to provide comments on non-fishing activities authorized by federal and state agencies which impact the EFH of non-anadromous fish species. The conservation and enhancement options promoted by the Council include, as directed in the Interim Final Rule: the enhancement of rivers, streams, and coastal areas; improving water quality and quantity; watershed analysis and planning; and habitat creation. The amendment primarily addresses recommendations from the Council to other organizations and agencies. By developing and articulating the options suggested to avert or minimize non-fishing threats to EFH, the Council defines its position relative to these types of activities.

Conservation and enhancement measures to protect fishery resources from fishing activities will include current fishery tactics and emerging fisheries that are not regulated and may present environmental considerations in the future. The Council has developed a list of recommendations to federal, state, and local agencies and non-governmental organizations to consider implementing into existing or developing conservation and enhancement programs. The Council will provide recommendations to address non-fishing threats to the appropriate action agencies and recommend the agencies incorporate EFH into all existing habitat-related programs when the EFH designations occur within their jurisdiction. Management approaches to mitigate adverse impacts from fishing and non-fishing activities that address the previous recommendations from the Council to other regulatory, collaborative, and non-governmental agencies may
include proactive conservation and enhancement measures to protect EFH. The Council will work closely with a variety of management authorities and non-profit organizations to incorporate EFH designations into existing initiatives and future management decisions, promote EFH awareness, develop measures to conserve and enhance EFH, and enforce existing conservation and enhancement measures.

1.6 RESEARCH AND INFORMATION NEEDS

The regulatory text of the Interim Final Rule directs the Council to include in the EFH amendment recommendations, preferably in priority order, for research efforts that the Council and NMFS view as necessary for carrying out their EFH management mandate. The need for additional research is to make available sufficient information to support a higher level of description and identification of EFH. Additional research may also be necessary to identify and evaluate actual and potential adverse effects on EFH including, but not limited to, direct physical alteration, impaired habitat quality / functions, cumulative impacts from fishing, or indirect adverse effects such as sea level rise, global warming and climate shifts, and non-equipment related fishery impacts. The need for additional research on the effects of fishing equipment on EFH is also included. The research needed to quantify and mitigate adverse effects on EFH identified in this amendment and determined to be an impediment to maintaining a sustainable fishery and the contribution of the managed species to a healthy ecosystem is identified. The research recommendations include expanded life history information that will result in the comprehensive identification of the habitat requirements of the species or species assemblages, including all life history stages, as well as habitat-related information that defines the interrelationship between the species, the environment and the food web. The identified research needs also include information on adverse impacts from both non-fishing and fishing activities. Fishing activities include both recreational and commercial fishing equipment or practices.

1.7 EFH STRATEGIC PLAN

Recognizing that the Council's Essential Fish Habitat Amendment is just the first step in the management of EFH, and that the Council has more to do to fulfill the intentions and mandates of the Sustainable Fisheries Act, the Council has developed a Strategic Plan. The EFH Strategic Plan explains how the Council will fulfill the regulatory requirement to review and revise the EFH components of its fishery management plans within five years, and also provides a context and structure within which the Council will work. The Strategic Plan addresses the processes and actions of the Council for a five year timeframe following implementation of the EFH Amendment. The Strategic Plan also describes how the Council intends to disseminate the information that results from the EFH process to the federal and state agencies with a direct or indirect role in the conservation and management of EFH, or whose actions or activities have the potential to adversely affect EFH. The Strategic Plan describes how the Council will implement the Magnuson-Stevens Act provision that authorizes the Council to comment to federal and state agencies on actions that may adversely impact the habitat, including EFH, of fishery resources under its authority, and requires the Council to comment on actions that would substantially impact the habitat, including EFH, of anadromous fishery resources under
its authority. The Strategic Plan consists of a goal statement for the Council's habitat program, a set of objectives for the Council's habitat program, and a description of the processes that the Council intends to implement to achieve the stated objectives.

1.8 ATLANTIC SALMON FMP PROVISIONS

In August, 1997 the Council voted to amend all NEFMC fishery management plans (FMPs) to include a framework adjustment process that would facilitate the timely approval of aquaculture projects that would otherwise require a full plan amendment. Since the concept of approving aquaculture projects through frameworks is a new addition to the list of “frameworkable” measures already listed in several Council FMPs, the public must be given an opportunity to comment on this proposal. For the sake of efficiency, consideration of an aquaculture framework adjustment process has been added to the FMP amendments now being developed to bring all NEFMC plans into compliance with the Sustainable Fisheries Act. This section also discusses an overfishing definition in the Fishery Management Plan for Atlantic Salmon.
2.0 INTRODUCTION

2.1 BACKGROUND

2.1.1 History

The Magnuson Fishery Conservation and Management Act of 1976, (renamed the Magnuson-Stevens Fishery Conservation and Management Act when amended on October 11, 1996) established a U. S. exclusive economic zone (EEZ) between 3 and 200 miles offshore, and established eight regional fishery management councils that manage the living marine resources within that area. The twenty-one member New England Fishery Management Council’s (Council) authority extends from Maine to southern New England and, in some cases, to the mid-Atlantic because of the range of the species.

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act, known as the Sustainable Fisheries Act (SFA), changed the focus of the Act by emphasizing the importance of habitat protection to healthy fisheries and by strengthening the ability of the National Marine Fisheries Service (NMFS) and the Councils to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed "essential fish habitat" and is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

2.1.2 New Requirements for NMFS, Councils, and Federal Agencies

To improve fish habitat protection, the SFA requires or authorizes that the Councils, NMFS, and other federal agencies take new actions. The SFA requires the Council, after receiving recommendations from NMFS, amend its fishery management plans by October 1998 to:

- describe and identify the essential habitat for the species managed by the Council
- minimize to the extent practicable adverse effects on EFH caused by fishing
- identify other actions to encourage the conservation and enhancement of EFH

The Council must describe EFH and identify adverse impacts and conservation measures for Atlantic herring, sea scallops, Atlantic salmon, and fifteen species of groundfish.

2.1.3 Strengthened Habitat Protection

Once fishery management plans are amended with EFH information, NMFS and the Councils will be more proactive in protecting habitat areas by alerting other federal and state agencies about areas of concern, and urging them to avoid planning projects in these areas. When projects are planned that may adversely affect EFH, the Councils and NMFS can recommend conservation measures to mitigate problems. The SFA requires federal agencies (and other entities funded by federal dollars) engaging in activities that may adversely affect EFH to consult with NMFS regarding those activities. NMFS (and the Councils) may make suggestions on how to mitigate any potential habitat damage.
Once these agencies receive NMFS' comments, they must respond in writing within 30 days, outlining the measures they are proposing to mitigate the impact of the activity on EFH. They must also explain any inconsistencies between the mitigation actions they propose with the recommendations made by NMFS.

2.1.4 EFH Roles and Responsibilities

The roles of NMFS, the Councils, and federal agencies in protecting EFH is detailed below, with citations provided to the appropriate section of the SFA (Public Law 104-267). (Source: Guidelines published in the Federal Register via an Interim Final Rule on December 19, 1997, Vol. 62, No. 244):

NMFS is required to:

- develop guidelines, by regulation, to assist the Councils in the description and identification of EFH in FMPs (including adverse impacts on EFH) and consideration of actions to ensure conservation and enhancement of EFH by April 11, 1997 (Section 305(b)(1)(A));
- develop schedules for amending FMPs for EFH, and for future periodic review of EFH amendments (Section 305(b)(1)(A));
- provide each Council with recommendations and information regarding EFH for each fishery under that Council’s authority (Section 305(b)(1)(B));
- review programs administered by the Department of Commerce and ensure that relevant programs further the conservation and enhancement of EFH (Section 305(b)(1)(C));
- consult with federal agencies regarding any activity, or proposed activity, authorized, funded, or undertaken by the agency that may adversely affect EFH (Section 305(b)(2));
- coordinate with and provide information to other federal agencies to further the conservation and enhancement of EFH (Section 305(b)(1)(D)); and,
- recommend conservation measures for any action undertaken by any state or federal agency that may adversely affect EFH (Section 305(b)(4)(A)).

The Councils are required or authorized to:

- submit FMP amendments to the Secretary to implement the EFH and other new FMP requirements by October 11, 1998;
- describe and identify EFH for the fisheries based on the guidelines established by NMFS, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of EFH (Section 303);
- comment on and make recommendations to NMFS and any federal or state agency concerning any activity, or proposed activity, authorized, funded, or undertaken by any federal or state agency that may adversely affect the habitat, including EFH, of a fishery under its authority (Section 305(b)(3)(A)); and,
• comment on and make recommendations to NMFS and any federal or state agency concerning an activity that is likely to substantially affect the habitat, including EFH, of an anadromous fishery. (Section 305(b)(3)(B))

Other federal agencies are required to:

• consult with NMFS regarding any activity, or proposed activity, authorized, funded, or undertaken by the agency that may adversely affect EFH (Section 305(b)(2)); and,
• provide NMFS and any Council that comments on an activity, or proposed activity, with a written description of the measures proposed by the agency for avoiding, mitigating or offsetting the impact of the activity on EFH within 30 days of receipt of a recommendation. If this response is inconsistent with NMFS recommendations, the agency must explain why it is inconsistent (Section 305(b)(4)(B)).

2.2 PURPOSE AND NEED

2.2.1 Purpose of Amendment

The purpose of the amendment is to identify and describe the EFH for all species of marine, estuarine, and anadromous finfish, and mollusks managed by the Council to better protect, conserve, and enhance this habitat. This amendment also will identify the major threats to essential fish habitat from both fishing and non-fishing related activities and identify conservation and enhancement measures.

2.2.2 Need for Improved Management

Fish in the coastal waters of New England, species of the continental shelf, and anadromous species that spawn in rivers or estuaries, constitute valuable and renewable natural resources. These fishery resources contribute to the food supply, economy, welfare, health, and recreational opportunities of the nation as well as New England. A habitat program is necessary to rebuild overfished stocks, to ensure conservation, to facilitate long-term protection of essential fish habitats, and to realize the full potential of the region's fishery resources. The Council is addressing these needs via this amendment to its fishery management plans.

2.2.3 Definitions

The Magnuson-Stevens Act defines essential fish habitat as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." For the purposes of interpreting this definition, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include historic areas where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and a healthy ecosystem; and
"spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

Fish habitat is where a fish species is found during some or all of its life. Fish habitat is used here both in the traditional sense where structure or substrate delineates its geographic boundaries (e.g., coral reefs, marshes, and kelp beds) and in the less conventional sense where boundaries are more fluid (e.g., turbidity zones, thermoclines, and fronts separating water masses). Historical fish habitat is the geographic area where a fish species was found at some point in time; this habitat may not be used now if the species distribution has changed or has been reduced, or access has been altered by man or natural events. Fish use habitat for spawning, breeding, migration, feeding and growth, and for shelter to reduce mortality. Most habitats provide only a subset of these functions. Fish habitat can change with life history stage, abundance, the presence of other species, and with temporal and spatial variability in the environment. The type of habitat available, its attributes, and its functions are important to the productivity of a fish species.

2.3 HABITAT POLICY AND MANAGEMENT OBJECTIVES

Recognizing that all species are dependent on the quantity and quality of their habitat, it is the policy of the New England Fishery Management Council to promote and encourage the conservation, restoration and enhancement of the habitat upon which living marine resources depend.

This policy shall be supported by four policy objectives which are to:

(1) Maintain and enhance the current quantity and quality of habitats supporting harvested species, including their prey base.

(2) Restore and rehabilitate fish habitats which have already been degraded.

(3) Create and develop fish habitats where increased availability of fishery resources will benefit society.

(4) Modify fishing methods and create incentives to reduce the impacts on habitat associated with fishing.

These objectives are based on ensuring the sustainability of harvested species and optimizing the societal benefits of our marine resources.

The Council shall assume an active role in the protection and enhancement of habitats important to marine and anadromous fish. In support of the Council’s habitat policy, the management objectives for the EFH amendment will be:

1. To the maximum extent possible, to identify and describe all essential fish habitat for those species of finfish and mollusks managed by the Council;  
2. To identify all major threats (fishing and non-fishing related) to the essential
fish habitat of those species managed by the Council; and,
3. To identify existing and potential mechanisms to protect, conserve and enhance the essential fish habitat of those species managed by the Council, to the extent practicable.

2.4 FISHERY MANAGEMENT UNITS

2.4.1 Atlantic salmon

The management unit for the Atlantic Salmon (*Salmo salar*) FMP is intended to encompass the entire range of the species of U.S. origin while recognizing the jurisdictional authority of signatory nations to North Atlantic Salmon Conservation Organization (NASCO). Accordingly, the management unit for this FMP amendment includes all anadromous salmonids of U.S. origin in the North Atlantic area throughout their migratory ranges except while they are found within any foreign nation’s territorial sea or fishery conservation zone (or the equivalent), to the extent that such sea or zone is recognized by the United States.

2.4.2 Atlantic herring

The Council is currently working to develop a fishery management plan for Atlantic herring (*Clupea harengus*), in conjunction with the Atlantic States Marine Fisheries Commission. In order to be as consistent as possible in designating and addressing EFH for all species, including Atlantic herring, this omnibus EFH amendment document includes all of the required EFH components of the proposed Atlantic herring FMP. Once the Atlantic herring FMP is complete, the EFH components related to Atlantic herring will be incorporated by reference.

The management unit for the proposed Atlantic herring FMP is defined as the Atlantic herring resource throughout the range of the species within the U.S. waters of the northwest Atlantic Ocean from the shoreline to the seaward boundary of the EEZ. The management unit does not include the entire range of the Atlantic herring stock complex. The stock complex includes herring which migrate through Canadian waters, beyond the range of management of the proposed Atlantic herring FMP.

2.4.3 Atlantic seascallop

The management unit for the Sea Scallop (*Placopecten magellanicus*) FMP consists of the sea scallop resource throughout its range in waters under the jurisdiction of the United States. This includes all populations of sea scallops from the shoreline to the outer boundary of the EEZ. The principal resource areas are the Northeast Peak of Georges Bank, westward to the Great South Channel, and southward along the continental shelf of the mid-Atlantic.

The management unit also includes populations found within the Gulf of Maine and Cape Cod Bay. These areas include the territorial seas throughout the range, primarily in Maine.
and Massachusetts. Fishing for sea scallops within state territorial waters is not subject to regulation under the Scallop FMP except for vessels that do not hold a federal permit when scalloping in state waters. Nonetheless, populations within state waters are included within the management unit in recognition of market interactions and the need for complementary state management action.

Five resource areas are generally defined within the management unit: Delmarva, New York Bight, South Channel and Southeast Part of Georges Bank, Northeast Peak and Northern Part of Georges Bank, and the Gulf of Maine. The Delmarva area includes scallops as far south as North Carolina.

2.4.4 Monkfish

The management unit for the Monkfish (*Lophius americanus*) FMP consists of the monkfish resource throughout its range in waters under the jurisdiction of the United States. This includes all populations of monkfish from the shoreline to the outer boundary of the EEZ. There are two management areas for monkfish, although management extends throughout the range of monkfish in U.S. waters. It is unclear if the monkfish resource in the Northwest Atlantic is composed of one, two, or several stocks.

2.4.5 Groundfish

The management unit for the Northeast Multispecies FMP is the multispecies (finfish) fishery that occurs from eastern Maine through southern New England, encompassing all commercial and recreational harvesting sectors in New England and all fish species that factor into a fishery within a trip, from trip to trip and from season to season, except those species that are subject to other fishery management plans under the Magnuson-Stevens Fishery Conservation and Management Act.

Multispecies fisheries management is inherently comprehensive in its scope and, consequently, cooperation from all relevant entities (state, regional, federal) is essential for effective achievement of this program’s management objectives. It is necessary that each species specifically regulated under this FMP shall be regulated throughout its range. Major species within this fishery that may be subject to specific regulation under this FMP amendment include:

- American plaice (*Hippoglossoides platessoides*)
- Atlantic cod (*Gadus morhua*)
- Atlantic halibut (*Hippoglossus hippoglossus*)
- haddock (*Melanogrammus aeglefinus*)
- ocean pout (*Macrozoarces americanus*)
- pollock (*Pollachius virens*)
- red hake (*Urophycis chuss*)
- redfish (*Sebastes spp.*)
white hake (Urophycis tenuis)
whiting (Merluccius bilinearis)
windowpane flounder (Scopthalmus aquosus)
winter flounder (Pleuronectes americanus)
witch flounder (Glyptocephalus cynoglossus)
yellowtail flounder (Pleuronectes ferruginea)

2.5 AMENDMENT DEVELOPMENT PROCESS

This amendment package amends all existing Council FMPs, including the Monkfish FMP, the Sea Scallop FMP, the Northeast Multispecies FMP, and the Atlantic Salmon FMP. This amendment package also includes components of the proposed Atlantic Herring FMP to address the required EFH elements. The EFH information related to Atlantic herring and contained herein will be incorporated by reference into the Atlantic Herring FMP. The Council had the option to submit separate EFH amendments to each of its FMPs, or to incorporate the EFH components into the FMP amendments addressing the other SFA requirements. The Council considered these options and determined that a single, omnibus EFH amendment was the most efficient and appropriate mechanism. This option eliminates unnecessary duplication (for instance, including the Non-Fishing Related Threats assessment in multiple FMP amendments), and allowed the Council to take a more "ecosystem-based" approach in the development of the amendment. In the future, any FMP amendments or new FMPs will include EFH provisions directly within the parent documents.

In developing this EFH amendment package, the Council divided the overall process into several distinct phases. The end result of each phase was one or more components of the amendment focused on one of the required elements. These components were integrated as amendment sections at the end of the development process, providing a single "omnibus" EFH amendment for all Council-managed species.

- The first phase of the process was identifying and describing the essential fish habitat for all Council-managed species. This was the most time-consuming phase of the process. NMFS developed species reports that detailed the life history and habitat requirements of each species and the Council considered and evaluated the available data on the distribution and abundance of each species.

- The second phase of the process was identifying and characterizing all known and potential adverse impacts to essential fish habitat, both from fishing-related and non-fishing related activities. This phase involved extensive literature reviews and included a special contracted report on the effects of fishing activities on habitat.

- The third phase was to identify a range of actions to mitigate the adverse impacts. For the fishing-related impacts, this took the form of a review of current Council management measures that may provide habitat conservation, a consideration of
new management measures, and expanding the framework adjustment process to include habitat concerns. Mitigation for the non-fishing impacts took the form of recommendations to state and federal agencies on measures to improve habitat protection.

- The fourth phase was to identify the range of information and research needs that the Council has in order to complete a more comprehensive assessment of essential fish habitat in the future. This phase also included developing a strategic plan for future Council EFH work.

The Council will continue to develop and refine these processes. Unfortunately, there are some limitations associated with this approach and the Council was required to make some assumptions, but it remains a scientific approach based on the best available information. Some limitations and assumptions of the process include:

- The primary sources of information for Council consideration were the NMFS surveys. The NMFS bottom trawl survey does not survey everywhere, and there are biases associated with where it does survey. The NMFS scallop survey does not necessarily survey where it is known that high densities of scallops occur. The results of the MARMAP survey are biased against certain types of eggs and larvae.

- State and inshore surveys are not necessarily compatible to NMFS data or each other, nor are they all complete and in electronic format. In fact, only one state, Massachusetts, had a survey that was used extensively by NMFS and the Council.

- None of the surveys actively collect the habitat information the Council and NMFS are most interested in (habitat type, substrate, biological associations, etc.).

- Additional sources of information (fishermen, historical, etc.) are sparse, difficult to verify, and largely anecdotal.

- There were no data available to the Council on many small estuaries along the coast, in spite of their apparent importance for fish production. The information that was available, from the NOAA Estuarine Living Marine Resource program, provided simply presence/absence (Level 1) information about a subset of the bays and estuaries in the New England and Mid-Atlantic regions.

- Certain habitat features, such as edges or transitions between different bottom types, rapid changes in topography, beds of benthic invertebrates (such as stalked ascidians and mussels), and special bottom structures such as clay pipes and gravel pavement, have been identified by fishermen and scientists as types of habitat features that appear very important to some species of fish (Dorsey and Pederson 1998). Unfortunately, most of these features occur as scales much smaller than the ten minute squares used by the Council.

However, even while faced with these limitations, the Council is reasonably assured of where most of the fish tend to be and where they tend to occur in higher concentrations. This is the first step toward a complete designation of essential fish habitat and meets the
objectives of the Interim Final Rule. Thus, for this amendment, the Council has designated EFH based on the limited information available, and set the stage for gathering new and better information. This additional information will help the Council eliminate the limitations of the current process and either verify or discredit the assumptions used. It is important to remember that this is but the first step in the process, and the Council will review and modify, as necessary, the EFH designations, as well as the other provisions of the EFH amendment.

2.6 HABITAT CHARACTERISTICS OF THE NEW ENGLAND REGION

2.6.1 Introduction

The EFH amendment focuses on three major, distinct geographic regions – the Gulf of Maine, Georges Bank, and the portions of the continental shelf south of New England (Figure 1). The topographic and oceanographic features of each region are distinct and support diverse biological communities. The diverse habitat conditions, oceanographic processes, and biological composition in New England waters form some of the most productive fishing grounds in the world.

Habitat can be difficult to define because there are different perspectives of what environmental conditions are important or unimportant to living resources. Habitat has been described at different spatial and temporal scales. Generally, habitat is thought of as a place where an organism is found (e.g. estuaries, tidal flats, seagrass meadows, cobble fields, etc.) (Peters and Cross 1992). Habitat has been described by the following definitions:

- the place where an organism lives or the place one would find it (Odum 1971);
- an area that performs a subset of all ecological functions (Edwards et al. 1992);
- that part of the environment on which organisms depend directly or indirectly to carry out their life processes (Deegan and Buchsbaum 1997);
- three levels of habitat include (1) the geographic range of the species, (2) its essential habitat, and (3) its critical habitat (i.e. the amount of habitat needed to sustain a viable population) (Cross et al. 1996);
- an essential resource for sustaining the production of commercially and recreationally important species (Langton et al. 1996); and,
- essential fish habitat is those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (SFA, P.L. 104-297).

The importance of habitat, in general, to the sustainability of fishery resources is a frequently discussed concept. Researchers have looked at particular habitat parameters at varying geographic and seasonal scales that appear to be important for the development of finfish and shellfish species. It is critical to describe essential habitat according to ontogenetic stage due to dramatic differences in species behavior, morphology, and habitat requirements throughout development. For example, organisms may exhibit
specific habitat shifts throughout life history stages for a variety of reasons (e.g. changing dietary requirements). Current and future research may further develop the descriptions of environmental variables important to fishery resources. Research may demonstrate and explain the dynamic nature of the marine environment and its relationship to fishery production.

2.6.2 Gulf of Maine

The Gulf of Maine is a deep, large, dynamic, coastal sea bound on the east, north, west, and south by Browns Bank, Nova Scotian Shelf, the New England States, Cape Cod, and Georges Bank, respectively (Figure 1). A suite of complex oceanographic conditions result in the rich biological community, highly variable bottom type and transport processes of the Gulf of Maine (Townsend 1991). Sediments (ranging from boulders to clay) were deposited in the Gulf of Maine during glacial retreat. Bottom sediment type is quite patchy and generally related to topography (Schlee 1973) and characterized by deep basins associated with silty clay or clay and topographic peaks exposed to winnowing and reworking action of the currents with sand and gravel (NEFMC 1993). Coastal regions are complex, such that, sediment type and texture vary from mud to boulders (Valentine and Schmuck 1995) (refer to Figure 2).

Three major basins (Georges, Jordan, and Wilkinson) exceed 250 meters in depth and are surrounded by irregular topographic features (Jeffreys Ledge, Stellwagen Bank, Platts Bank, Cashes Ledge, Browns Bank, and Georges Bank) (Figure 1). The Northeast Channel (located between Browns and Georges Bank) and the Great South Channel (located between Georges Bank and Nantucket Shoals) connect the Gulf of Maine to the north Atlantic.

Currents (tidal, wind, and storm-induced) (Witman 1996) and seasonal variability of water properties appear to be major physical forces related to the productivity of the Gulf of Maine. There is a general counterclockwise current around the Gulf of Maine influenced by water masses from the Scotian Shelf and offshore (Figure 3). Many gyres and minor currents occur within the Gulf (Lynch 1996). Coastal currents also move counterclockwise, except south of the Penobscot Bay region where a portion of the current turns offshore towards Jeffreys Ledge and the shallow topography between Jordan and Wilkinson Basin (Brooks 1985). Freshwater run-off from numerous rivers along the coast of the Gulf of Maine substantially influences coastal circulation, phytoplankton blooms, and overall productivity (Townsend 1992). While there is an increasing amount of information on patterns of distribution and abundance of macrofauna at the scale of local sites (Watling et al. 1988; Langton and Watling 1990; Langton et al. 1990), there is little quantitative information on the distribution of benthic assemblages on larger Gulf of Maine-wide scales (Witman 1996). Understanding the variable relationship between fisheries and the environment is needed for effective habitat-based management for the marine resources of the Gulf of Maine (Townsend 1992; Langton and Haedrich 1996).
Figure 1: The New England region, including Gulf of Maine, Georges Bank, and Nantucket Shoals.
Surveys have attempted to describe biological associations over a large geographic region in the Gulf of Maine. Demersal fish groups associated with large geographic areas have been discussed for the Georges Bank and Gulf of Maine regions (Table 1) (reviewed by Langton et al. 1994). Gordon (1994) illustrates there are three distinct herring stocks in the Gulf of Maine; herring spawning beds are restricted in area to more complex bottom structure with strong currents for preferential egg attachment conditions. Other studies demonstrate small-scale invertebrate distributions in the Gulf of Maine (Theroux and Grosslein 1987; Watling et al. 1988; Langton and Uzmann 1990).

2.6.3 Georges Bank

Georges Bank is a shallow (3-150 m water depth), elongate extension of the northeastern U.S. Atlantic continental shelf (Valentine and Lough 1991) formed by the Wisconsinan glacial episode (Valentine et al. 1993) (Figure 1). The Bank is a submarine plateau (Fogarty and Murawski 1998) characterized by a steep slope on its northern edge and a broad, flat, gently sloping southern flank. It is separated from the rest of the continental shelf to the west by the Great South Channel. The central region of the Bank is shallow, and the bottom is characterized by large amplitude sand waves (Emery and Uchupi 1972). Valentine et al. (1993) researched and summarized the surficial sediment, topography, and currents of eastern Georges Bank to be used in conjunction with faunal distribution maps of the region. Glacial retreat during the late Pleistocene deposited the bottom sediments currently observed on eastern Georges Bank, and the sediments have been continuously reworked and redistributed by the action of rising sea level, tidal, storm, and other currents (Valentine and Lough 1991). The nature of the sea bed sediments varies widely on Georges Bank, ranging from clay to gravel (Figure 2).

Currents on Georges Bank include a weak, persistent clockwise gyre around the bank, strong semidiurnal tidal flow predominantly northwest and southeast, and very strong, intermittent storm-induced currents, occurring simultaneously (Valentine et al. 1993). Sherman et al. (1996) describes tidal currents over the shallow top of Georges Bank as very strong, accounting for more than 80% of the total current variance near and over the bank. The vigorous tidal currents keep the waters over the bank well mixed vertically resulting in a tidal front that separates the cool waters of the well-mixed shallows from the warmer seasonally stratified shelf waters on the seaward and shoreward sides of the bank (Sherman et al. 1996) (Figure 3).

Bottom topography on eastern Georges Bank is characterized by linear ridges in the western shoal areas; relatively smooth, gently dipping sea floor on the deeper, eastern most part of the bank; and steeper and smoother topography incised by submarine canyons on the southeastern margin (Valentine et al. 1993). Oceanographic frontal systems separate water masses from the Gulf of Maine and the remainder of the Atlantic on Georges Bank and differ in temperature, salinity, nutrient concentration, and planktonic communities (Valentine and Lough 1991) which influence productivity and may influence fish abundance and distribution. The interaction of environmental factors (i.e. availability and type of sediment, current speed and direction, and bottom topography) have been investigated thoroughly and form seven sedimentary provinces on eastern Georges Bank (Valentine et al. 1993). Approximate depth ranges are provided in
brackets for each of the seven provinces:

1. **Northern edge**: Dominated by gravel with portions of sand, common boulder areas, and tightly packed pebbles. Epifauna (bryozoa, hydrozoa, and worm tubes) are abundant in areas of boulders where bottom trawling is low. [40 - 200 meters]

2. **Northern slope and Northeast Channel**: Variable sediment type (gravel, gravel-sand, and sand) with ripples and scattered bedforms. This is a transition zone between the northern edge (1) and southern slope (7). [200 - 240 meters]

3. **North-central shelf**: Highly variable sediment type (ranging from gravel to sand) with rippled sand, large bedforms, and patchy gravel lag deposits. [60 - 120 meters]

4. **Shoal ridges, and central and southwestern shelf**: Dominated by sand (fine and medium grained) with large sand ridges, dunes, waves, and ripples. Small bedforms in southern part. [10 - 80 meters]

5. **Shoal troughs**: Gravel (including gravel lag) and gravel-sand between large sand ridges. Patchy large bedforms. Strong currents. Few samples – submersible observation noted presence of gravel lag, rippled gravel-sand, and large bedforms. [40 - 60 meters]

6. **Southeastern shelf**: Rippled gravel-sand (medium and fine-grained sand) with patchy large bedforms and gravel lag. Weaker currents. [80 - 200 meters]

7. **Southeastern slope**: Dominated by silt and clay with portions of sand (medium and fine) with rippled sand on shallow slope and smooth silt-sand sheet deeper. [400 - 2000 meters]

Natural processes continue to erode and rework the sediment type and availability on Georges Bank. Erosion and reworking of sediments will increase the amount of gravel pavement and less sand will be available to the sand sheets causing an overall coarsening of the bottom sediments of Georges Bank (Valentine *et al.* 1993). The physical disturbance of the seabed caused by strong, erosive currents (tidal and storm) potentially dictates the character of the biological community (Valentine and Lough 1991).

Georges Bank is characterized by high levels of primary productivity and, historically, high levels of fish production (Fogarty and Murawski 1998). It has a diverse biological community that is influenced by many environmental conditions. Several studies have attempted to identify demersal fish assemblages over large spatial scales on Georges Bank. Five depth-related groundfish assemblages were persistent temporally and spatially, with depth and salinity identified as major physical influences explaining the assemblage structure. The assemblages appeared to maintain temporal integrity and spatial configuration for the survey period (Table 1) (Overholtz and Tyler 1985).
Figure 2: Map showing distribution of surficial sediments, Gulf of Maine, Georges Bank, and southern New England. Southern New England surficial sediment distribution similar to the Mid-Atlantic Bight region (Figure reproduced from Poppe et al. 1989).
Figure 3: Map showing water mass circulation patterns in the Georges Bank – Gulf of Maine region. Water masses exhibit distinctive physical patterns (temperature, salinity, stratification, mixing, nutrient concentration). Mixing of bottom and surface waters in shallow areas by strong tidal currents recycles nutrients which leads to high biological productivity. Depths in meters. (after: Brooks 1985; Loder and Greenberg 1986; Butman et al. 1987) (figure reproduced from Valentine and Lough 1991).
Table 1: Demersal fish assemblages of Georges Bank and the Gulf of Maine based on a large geographic scale, for the period of 1963 - 1978 (Overholtz and Tyler 1985).

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<tr>
<th>Slope and Canyon</th>
<th>Intermediate</th>
<th>Shallow</th>
<th>GOM Deep</th>
<th>Northeast Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>whiting</td>
<td>red hake</td>
<td>whiting</td>
<td>American plaice</td>
<td>Atlantic cod</td>
</tr>
<tr>
<td>white hake</td>
<td>Atlantic cod</td>
<td>haddock</td>
<td>witch flounder</td>
<td>haddock*</td>
</tr>
<tr>
<td>red hake</td>
<td>haddock</td>
<td>white hake</td>
<td>pollock</td>
<td>pollock</td>
</tr>
<tr>
<td>offshore hake</td>
<td>monkfish</td>
<td>red hake</td>
<td>white hake</td>
<td>white hake</td>
</tr>
<tr>
<td>monkfish</td>
<td>ocean pout</td>
<td>yellowtail flounder</td>
<td>Atlantic cod</td>
<td>winter flounder</td>
</tr>
</tbody>
</table>

* majority of haddock was collected in the Northeast Peak group

2.6.4 Southern New England

The continental shelf south of New England is broad and flat. The sedimentary composition is dominated by fine grained sediments. Sand dominates surficial bottom sediment composition with regions of clayey sand/silty sand, sandy silt/clayey silt, and gravel-sand. Gravel pavement and other coarse sediments are found sporadically on relatively small geographic scales throughout the region. Southeast of Nantucket, the Nantucket Shoals is characterized by sand waves and patches of gravel on the western flank of the Great South Channel. Finer sediments (sandy clay/silt clay) dominate the bottom further offshore (Poppe et al. 1989) (Figure 2).

Faunal associations were described at a broad geographic scale for the middle Atlantic bight continental shelf demersal fishes, based on the NMFS Bottom Trawl Survey, 1967-1976 (Table 2) (Colvocoresses and Musick 1983). There were clear variations in species abundances, yet they demonstrate consistent patterns of community composition and distribution among demersal fishes of the middle Atlantic continental shelf, especially for five strongly recurring species associations. The boundaries between fish assemblages generally followed isotherms and isobaths. The species assemblages were largely similar between the spring and fall collections with the most notable change being a northward and shoreward shift in the temperate group in the spring. Although substrate preferences were not generated during this study, comparison of species group distribution with bottom sediment maps do not demonstrate any strong species group – substrate relationship. The major recurrent, dominant species groups were associated with the continental shelf region and distinguished for the spring and fall (Colvocoresses and Musick 1983).
Table 2: Major recurrent demersal species groups of the middle-Atlantic bight area during the spring and fall (boreal $\equiv$ northern regions; warm temperate $\equiv$ southern region). (Colvocoresses and Musick 1983).

**Spring**

<table>
<thead>
<tr>
<th>Boreal</th>
<th>Warm Temperate</th>
<th>Inner Shelf</th>
<th>Slope Resident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic cod</td>
<td>black sea bass</td>
<td>windowpane</td>
<td>shortnose greeneye</td>
</tr>
<tr>
<td>little skate</td>
<td>summer flounder</td>
<td></td>
<td>offshore hake</td>
</tr>
<tr>
<td>sea raven</td>
<td>butterfish</td>
<td></td>
<td>blackbelly rosefish</td>
</tr>
<tr>
<td>monkfish</td>
<td>scup</td>
<td></td>
<td>white hake</td>
</tr>
<tr>
<td>winter flounder</td>
<td>spotted hake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>longhorn sculpin</td>
<td>northern searobin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ocean pout</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>whiting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>red hake</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>white hake</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>spiny dogfish</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fall**

<table>
<thead>
<tr>
<th>Boreal</th>
<th>Warm Temperate</th>
<th>Inner Shelf</th>
<th>Slope Resident</th>
</tr>
</thead>
<tbody>
<tr>
<td>white hake</td>
<td>black sea bass</td>
<td>windowpane</td>
<td>witch flounder</td>
</tr>
<tr>
<td>whiting</td>
<td>summer flounder</td>
<td></td>
<td>offshore hake</td>
</tr>
<tr>
<td>red hake</td>
<td>scup</td>
<td></td>
<td>white hake</td>
</tr>
<tr>
<td>monkfish</td>
<td>spotted hake</td>
<td></td>
<td>shortnose greeneye</td>
</tr>
<tr>
<td>longhorn sculpin</td>
<td>butterfish</td>
<td></td>
<td>blackbelly rosefish</td>
</tr>
<tr>
<td>winter flounder</td>
<td>northern searobin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>yellowtail flounder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>witch flounder</td>
<td>smooth dogfish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>little skate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>spiny dogfish</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.6.5 General Habitat Features

Biological Characteristics

Fish distribution and abundance data are used as a proxy for identifying locations of EFH. It is important to understand and consider species assemblages when discussing habitat features. Several faunal associations among northwest Atlantic groundfish have been identified (Colvocoresses and Musick 1983; Overholtz and Tyler 1985; Mahon and Smith 1989). For example, surveys on the Scotian Shelf demonstrate close associations among groundfish stocks (Mahon and Smith 1989). White hake and witch flounder appear closely associated throughout the year with whiting joining the assemblage in the summer. Haddock and halibut populations appear to be closely related with Atlantic cod joining the complex in the spring. Mahon and Smith (1989) provided a large-scale view of the associations between demersal finfish species of the northwest Atlantic.

The spatial and temporal boundaries of prey abundance can influence survivorship, recruitment, and development of any organism (e.g. Fortier and Gagne 1990). For example, populations of sand lance (Ammodytes spp.) are important sources of nutrition for many piscivorous fishes. Benthic invertebrates are the main source of nutrition for
many adult demersal fishes (EFH Species Source Documents, Appendix A). The diversity of prey composition found in the dietary analysis of the food habits survey (NMFS 1973 to present) demonstrates the importance of prey supply and distribution to adult and juvenile finfish species. Plankton abundance and distribution may also be a great influence on ichthyoplankton community structure and distribution (Lough and Potter 1993). Early life history fishes are very susceptible to starvation. Therefore, suitable prey supply is an important factor in the survivorship and development of larval and early juvenile fishes. Oceanographic properties often dictate the structure and concentration of plankton communities. Differences in prey availability may influence the abundance and distribution of organisms on every trophic level. Trophic linkages are an important biological characteristic that can potentially dictate the state of fish populations.

Emergent epifauna often contribute to the survivorship of marine organisms because of the increased cover and habitat complexity they provide. A number of studies document the ecological importance of invertebrate growth, cover, and density (e.g. Auster et al. 1991; Auster et al. 1995; Auster et al. 1997). Along with other environmental conditions, submerged aquatic vegetation is also cited as an ecologically important habitat component providing numerous functions in shallow coastal waters (e.g. Short and Burdick 1994).

**Marine Sediments**

Sedimentary composition of the ocean floor is highly variable in the Gulf of Maine, Georges Bank, and southern New England (Figure 2). Sediments differ in origin, texture, size, transport mechanism, and distribution. Bottom habitats in New England waters are heterogeneous, characterized by patchy surficial sediment composition and irregular topographic peaks. Research demonstrates that fish distributions are often closely associated to specific sediment types (e.g. Scott 1982; Lough et al. 1989; Langton and Uzmann 1990; Valentine and Lough 1991; Langton et al. 1995; Auster et al. 1997; Valentine and Lough 1991; Valentine et al. In Press). The Gulf of Maine, Georges Bank, and southern New England (which is very characteristic of the middle Atlantic bight sedimentary composition) have similar types of sediments but they occur in distinctly different composition and pattern (Table 3).

Several studies document the importance of seafloor habitats predominantly composed of gravel for the survivorship of certain early life history fishes (Lough et al. 1989; Valentine and Lough 1991; Auster and Malatesta 1995; Lindholm et al. In Press). Valentine and Lough (1991) demonstrate the importance of gravel for the settlement of haddock and Atlantic cod. Gravel appears to provide predation refuge and an abundant prey supply, increasing the survivorship of cod (Lough et al. 1989; Valentine and Lough 1991; Goteceitas and Brown 1993; Tupper and Boutilier 1995; Valentine and Schmuck 1995; Lindholm et al. In Press). Gravel has also been noted as an important habitat feature for other demersal species such as winter flounder, yellowtail flounder, longhorn sculpin, and little skate. Atlantic herring spawning grounds have also been closely related to gravel substrate and strong tidal currents (Sinclair and Iles 1985; Valentine and Lough 1991). Gravel provides a firm substrate for egg attachment. For example, suitable
environmental conditions for herring spawning grounds appear to be limited to the shallow, western part of the gravel pavement on Georges Bank’s northern edge which lies between sand ridges (Sinclair and Iles 1985; Valentine and Lough 1991). Gravel has also been noted as important to the recruitment and settlement of Atlantic sea scallops (Valentine and Lough 1991), and increasing the survivorship of lobsters (Wahle and Steneck 1992). Gravelly substrates are often associated with biologically diverse communities that are dominated by emergent epifauna and other biogenic structures, such as calcareous worm tubes, bryozoans, and cerianthid anemones (Valentine and Lough 1991; Collie et al. 1997), which provide some level of cover and refuge.

Table 3: Type of surficial sediment* observed on the seafloor of the New England region.

<table>
<thead>
<tr>
<th>SEDIMENT TYPE</th>
<th>REGION</th>
</tr>
</thead>
<tbody>
<tr>
<td>bedrock</td>
<td>GOM</td>
</tr>
<tr>
<td>gravel¹</td>
<td>GOM, GB², SNE³</td>
</tr>
<tr>
<td>gravel-sand</td>
<td>GOM, GB, SNE</td>
</tr>
<tr>
<td>sand</td>
<td>GOM, GB, SNE</td>
</tr>
<tr>
<td>clayey sand/silty sand</td>
<td>GOM, GB, SNE</td>
</tr>
<tr>
<td>sandy silt/clayey silt</td>
<td>GOM, SNE</td>
</tr>
<tr>
<td>clay</td>
<td>GOM, GB</td>
</tr>
<tr>
<td>sandy clay/silty clay</td>
<td>GOM, SNE</td>
</tr>
<tr>
<td>sand/silt/clay</td>
<td>GOM, SNE</td>
</tr>
</tbody>
</table>

* sediment classifications from Poppe et al. (1989)
¹ gravel includes cobble and boulders
² boulders common on the northern edge and northeast Peak of GB (Valentine and Lough 1991)
³ SNE (southern New England) is geologically similar to the middle Atlantic bight

Surficial sediments composed of a gravel-sand mix have also been noted as important postlarval fish habitat for Atlantic cod, haddock, winter flounder, yellowtail flounder, and others (Valentine and Lough 1991). American plaice adults have been demonstrated to associate with gravel-sand sediments (Scott 1982) for a variety of potential reasons (e.g. appropriate coloration for predation refuge and abundant prey availability). Gravel-sand sediments have been noted as recruitment and settlement habitat for sea scallops where the movement of sand is relatively minor (Langton and Uzmann 1990; Valentine and Lough 1991). In the New England region, the gravel-sand mixture is usually a transition zone between coarse gravel and finer sediments (Valentine and Lough 1991).

Sand provides suitable environmental properties for a variety of fishes, invertebrates, and microorganisms and forms large dunes and ridges that may be used by a number of organisms. Invertebrates, such as surf clams, razor clams, and quahogs, burrow between the grains to support their characteristic sessile behavior. Dunes and ridges provide refuge from currents and predators and habitat for ambush predators (Valentine and Lough 1991). Several important prey species inhabit sand habitats (e.g. amphipods, polychaetes, etc.) that flounders prefer. Yellowtail and winter flounder distribution has been correlated to sand (Langton and Uzmann 1990). In general, flatfishes are more
closely associated with sand and finer sediments than other demersal fishes.

Fine sediments which include sand, silt, clay, and various combinations of the three are generally found in deeper basins and on smooth topography in the New England region (Valentine and Lough 1991). Fine sediments form bedforms on the seafloor and provide some level of predation refuge, protection against currents, and burrowing habitat for an array of invertebrates. Whiting, winter flounder, American plaice, ocean pout, and snake blennies have been primarily associated with fine sediments (Scott 1982; Langton and Uzmann 1990).

Sediment type alone does not necessarily constitute an important habitat condition. Sediment texture and biogenic structures, along with sediment type, have been demonstrated to be important features with which northwest Atlantic continental shelf fishes associate (reviewed by Auster et al. In Press). Auster et al. (In Press) developed a hierarchical classification of microhabitat types based on sediment characteristics, vertical relief, and spatial complexity. In general, increases in habitat complexity refer to greater vertical relief and increased variability in the size of interstices between structures and may result in higher survivability of demersal fishes (Auster and Malatesta 1995; Lindholm et al. In Press). The following classification may be an important component to overall habitat conditions in New England waters, based on habitat complexity (categories based on Auster et al. 1995; Langton et al. 1995; Auster et al. 1996; and reviewed and Auster and Langton MS1998):

- **smooth sand or mud**: areas with no vertical structure
- **sand waves**: troughs and peaks provide shelter from current; previous observations indicate species such as whiting position themselves on the downcurrent sides of sand waves where they ambush drifting demersal zooplankton and shrimp
- **biogenic structures**: burrows, depressions, cerianthid anemones, hydroid patches; features that are created and / or used by mobile fauna for shelter
- **shell aggregates**: provide complex small interstitial spaces for shelter; shell aggregates also provide a complex high contrast background which may confuse visual predators
- **pebbles and cobbles**: provide small interstitial spaces and may be equivalent in shelter value to shell aggregates
- **pebbles and cobbles with attached megafauna**: attached fauna such as sponges provide additional spatial complexity for a wider range of size classes of mobile organisms
- **partially buried boulders**: while not providing small interstitial spaces or deeper crevices, partly buried boulders exhibit high vertical relief; the shelter value of this type of habitat may be less or greater than previous types based on the size class and behavior species
- **piled boulders**: this habitat provides deep interstitial spaces of variable sizes.
Bottom topography, along with sediment type, may also influence the distribution and abundance of benthic, demersal, and pelagic organisms. Geologic features such as submarine canyons, rock ledges, and topographic peaks are potential habitat components that are potentially important to a variety of marine organisms. Bottom topography is often associated with particular sediment types (e.g. deep-water canyons and fine sediments), and may contribute to suitable environmental conditions for the survivorship, growth, and reproduction of fishery resources.

Ocean Circulation and Tides

Pelagic habitats are difficult to describe because the pelagic region is poorly understood at scales that allow for observations of change in conditions. Pelagic conditions can, however, be defined based on temperature, light intensity, turbidity, oxygen concentration, currents, frontal boundaries, and a host of oceanographic parameters and patterns. There are relatively few published data that relate the variability of these environmental factors to fishery resources and habitat conditions on large geographic and seasonal scales. Thus, oceanographic features are dynamic, interactive, and highly variable temporally and spatially (Robinson 1998). The New England region is characterized by semidiurnal tides, major and minor currents, variable fronts and eddies, and several convergence and divergence zones (based on average circulation rates) (Figure 3). The tidal flux in New England provides rapid exchange of nutrients, dissolved organic matter, and detrital material from coastal waters to offshore regions. The nutrient levels are greatly influenced by riverine discharge into the coastal environment, especially along the coast of Maine. The nutrient rich waters are the base of the trophic web in the Gulf of Maine, Georges Bank, and southern New England ecosystems, providing a portion of the nutritional requirements for phytoplankton. The tidal range and flux in New England influences many of the physical features (e.g. depth) and oceanographic processes (e.g. currents) that may be associated with the distribution and abundance of biological communities (Klein 1987).

The currents in New England are primarily influenced by the tidal cycle, but short-term, storm-induced currents also occur, especially in winter. Currents play an important role in supplying areas with oxygenated waters, nutrients, and organic matter. The abundance and distribution of ichthyoplankton and other planktonic organisms may be influenced by currents which may affect the population dynamics of finfish and shellfish of New England. Currents and gyres vary on a wide range of geographic and time scales (Beardsley et al. 1996). Tidal currents generate strong turbulent mixing in water layers, and storm-induced currents also generate mixing of the water column (Beardsley et al. 1996). Mixing the water column to supply critical nutrients to the sea surface waters is an important component of the overall nutrient cycle. Currents are also major transport mechanisms for plankton communities. Organisms are transported throughout the Gulf of Maine, Georges Bank, and southern New England regions. Gyres may restrict the transport of some organisms (e.g. ichthyoplankton) by trapping them in a relatively small geographic area. For example, Lough and Potter (1993) describe and summarize the transport and development of Atlantic cod and haddock eggs and larvae in the Georges Bank region; egg patches passively drift southwest in a clockwise residual pattern around
Georges Bank, larval concentrations are found at varying depths along the southern edge of Georges Bank between the 60 m and 100 m isobath, the concentration moves southwest toward the shoals of western Georges Bank, and larvae metamorph to juveniles and settle to demersal habitat with a consistent high density of juvenile gadids collected on eastern Georges Bank. Currents and gyres contribute to the diverse biological community of the New England region.

Currents and tides may also generate fronts, eddies, and divergence and convergence zones that may provide suitable habitat conditions to a suite of organisms. Fronts, eddies, and other convergence zones may function as a congregation area for complexes of organisms and influence the population dynamics of a region. Planktonic organisms may be especially influenced by the circulation of water masses (e.g. transport mechanism). Congregation zones may include areas of high primary productivity, high plankton concentrations, and efficient foraging habitats for larval fishes and other planktonic organisms. Larger organisms may also target fronts and eddies to prey upon the high density of planktonic organisms. Convergence zones (e.g. two currents coming together) may also act as transport mechanisms, supplying food-rich surface waters to the seafloor. Divergence zones (e.g. currents moving away from each other), including upwelling events, have been associated with phytoplankton blooms. Divergence zones transport nutrient-rich bottom waters to the sea surface and promote primary production. These oceanographic features may provide necessary habitat conditions for the survivability, development, and growth of a variety of organisms at particular ontogenetic stages.

Other physical oceanographic properties may contribute to pelagic habitat conditions, such as stratified water layers (e.g. thermoclines, haloclines, and pycnoclines), internal waves, plumes (e.g. riverine discharge), and others (e.g. Langmuir cells). Ekman and Stokes transport (drift) (Leis 1991) are oceanographic features that may contribute to planktonic transport and suitable environmental conditions. Physical oceanography constitutes several roles that influences several aspects of fishery resources and habitat conditions, including the transporting planktonic organisms and water masses throughout New England waters. Population dynamics and habitat conditions in New England are greatly influenced by oceanographic processes.

**Submerged Aquatic Vegetation**

The primary types of submerged aquatic vegetation (SAV) in New England are eelgrass (Zostera marina) and widgeon grass (Ruppia maritima). Kelp and rockweeds are abundant benthic seaweeds within New England waters. Seagrass and rockweed are found along the coast of the Gulf of Maine and southern New England, and kelp is usually limited to the coast of the Gulf of Maine. SAV plays an integral role in the development and sustainability of important living resources. Research has documented the importance of the ecological functions of SAV (ASMFC 1997).

Eelgrass and widgeon grass, along with all other seagrasses, function as a filter for the maintenance of water quality and fisheries habitat (Short and Burdick 1994). Seagrass serves as nursery grounds for a number of commercially and recreationally important species, specialized refuge, a rich food source for herbivores, and a life cycle transition
zone (Short and Burdick 1994; ASMFC 1997). For example, Atlantic cod have been associated with SAV, possibly using it for predation refuge (Gotceitas et al. 1997). Eelgrass has also been noted to serve as an attachment site for primary settlement of blue mussels (Univ. of ME and Univ. of NH Sea Grant College Program 1994). Seagrass plays several important ecological functions, including a role in the chemical cycling of water, filtering and accumulating toxics and nutrients from the water, supporting epiphytic growth, and physical stabilization of the sediments (Short and Burdick 1994; ASMFC 1997).

Kelp also functions as a complex habitat, providing refuge from predators and foraging habitat for a variety of marine and estuarine organisms. For example, sea scallops, winter flounder, and lobsters have been documented to inhabit kelp forests. Kelp is also a harvestable plant with an expanding market. Rockweed is also an important habitat feature providing cover for a variety of finfish and shellfish species. Kelp, rockweed, and seagrass function as a source of detritus and primary productivity that is important in the numerous chemical and biological cycles in New England waters.

Coastal Features

The New England coast is probably best known for its magnificent scenery and vacation locations, but the coast of the Gulf of Maine and southern New England have a variety of aquatic, estuarine, and marine ecosystems that serve important ecological functions for many fishery resources. Salt marshes, mud flats, rocky intertidal zones, and sandy beaches are critical to inshore and offshore habitat conditions.

Salt marshes are found throughout the Gulf of Maine where suitable environmental conditions exist, with major marshes located on Cape Cod, the north shore of Massachusetts, and the coast of Maine (Gordon 1994). Tidal and subtidal mud and sand flats are general salt marsh features. Extensive mud and sand flats are found throughout the Gulf of Maine wherever proper sedimentary conditions exist, particularly in Cape Cod Bay (Gordon 1994). Salt marshes are important components of estuarine and coastal habitat, and provide nursery and spawning habitat for many finfish and shellfish species. Salt marsh vegetation is also a large source of organic material (detritus) that is important to the biological and chemical processes of the estuarine and marine environment. Salt marshes provide a large amount of prey for recreational and commercial organisms. Waterfowl and shorebirds also require salt marsh habitats for nesting, feeding, and cover. Salt marshes play an important role in the marine environment and support a number of fishery resources.

Rocky intertidal zones are periodically submerged, high energy environments. Rocky shores are most common around Cape Ann, Massachusetts and along the coast of Maine. Sessile invertebrates and some fish inhabit rocky intertidal zones. A variety of algae, kelp, and rockweed are also important habitat features of rocky shores. Fishery resources may depend on particular habitat features of the rocky intertidal zones, which provide important levels of refuge and nutrient sources. Rocky shores are also known for their importance to colonial seabirds.
Sandy beaches are most extensive along the coasts of Rhode Island, Massachusetts, New Hampshire, and Maine (Gordon 1994). Different zones of the beach present suitable habitat conditions for a variety of marine and terrestrial organisms. For example, the upper beach is necessary for dune grasses, sand fleas, invertebrates, and nesting birds. The intertidal zone presents suitable habitat conditions for many invertebrates and foraging habitat for birds. Several invertebrates and fish are adapted for living in the subtidal zone adjacent to sandy beaches, and transient fish find suitable conditions for foraging, among other activities, in the subtidal region. Beaches exhibit necessary habitat conditions and function as foraging and spawning habitats for marine resources.

Inland Wetlands

New England has a variety of palustrine wetlands that may directly and indirectly influence adjacent estuarine and marine habitats. Palustrine habitats include forested swamps, scrub-shrub, and emergent marshes (reviewed by Pedevillano 1995). Forested swamps provide habitat for a variety of birds, mammals, reptiles, amphibians, and invertebrates. They provide feeding, breeding, nesting, overwintering, and migration habitat. Scrub-shrub habitat is also used by diverse wildlife for feeding, nesting, breeding, and cover. Emergent marshes are a major source of surface water, and provide important habitat for a variety of aquatic and terrestrial organisms. Palustrine habitats are also important in cycling nutrients. Inland wetlands are necessary for a variety of organisms that may be critical to estuarine and marine resources and conditions.

Lacustrine habitats include reservoirs and flooded lakes that provide important breeding and foraging habitat for many natural resources. Rivers provide habitat for a variety of fishery resources and other wildlife (e.g. Atlantic salmon). Riverine conditions are important in providing hydrologic connections between coastal and inland habitats. Vegetation associated with riverine habitats provide suitable environmental conditions for birds, mammals, reptiles, amphibians, and insects that may be important trophic components to freshwater wetlands and estuaries. Riverine habitat conditions are important for the maintenance of healthy aquatic, estuarine, and marine environments and fishery resources.

2.6.6 Discussion

The New England region is characterized by heterogeneous environmental conditions which provides suitable habitat conditions for a diverse collection of living marine resources that are important to the overall health and productivity of New England waters. The interaction of biologic, geologic, and oceanographic features of the Gulf of Maine, Georges Bank, and southern New England sustains, historically, one of the most productive fishing grounds in the world. Fishery resources are influenced by a variety of habitat properties from terrestrial wetlands to seafloor sediment types. Taking into account the multitude of geographic and temporal scales and environmental parameters that potentially interact to influence the distribution and abundance of finfish and shellfish stocks, identifying isolated habitat components may demonstrate particular conditions suitable for fishery resources. The ecological importance of habitat features such as seafloor sediments and submerged aquatic vegetation have been thoroughly
demonstrated (e.g. Valentine and Lough 1991; Short and Burdick 1994). Extensive research on the ecological importance of structurally complex seafloor (e.g. gravel pavement with emergent epifauna) for several managed fish (e.g. Atlantic cod) demonstrates the relationship between fishery production and habitat conditions. Further development of multivariate relationships between biological, chemical, and physical features will increase the understanding of the marine environment and advance the evidence of direct links between habitat conditions and fish productivity.

3.0 DESCRIPTION AND IDENTIFICATION OF ESSENTIAL FISH HABITAT

The regulatory text of the Interim Final Rule (Federal Register Vol. 62 No. 244, December 19, 1997) directs the Council to describe EFH in text and with tables that provide information on the biological requirements for each life history stage of the species. These tables are provided in the individual species reports (Appendix A) and summarize all available information on environmental and habitat variables that control or limit distribution, abundance, reproduction, growth, survival, and productivity of the managed species.

The regulatory text of the Interim Final Rule also directs the Council to present the general distribution and geographic limits of EFH for each life history stage in the form of maps. These maps are presented as fixed in space and time, but they encompass all appropriate known temporal and spatial variability in the distribution of EFH. The EFH maps are a means to visually present the EFH described in the amendment.

There are two distinct but related components of the process to comply with the guidelines of the Interim Final Rule: (1) developing the text description of essential fish habitat; and, (2) identifying the geographic extent of essential fish habitat. Together, they provide a picture of the EFH for Council-managed species. Table 4 lists the species, and their common names, for which the Council is designating EFH.

3.1 DESCRIPTION OF ESSENTIAL FISH HABITAT

To support the Council, NMFS developed source document reports for each species managed by the Council, with the exception of Atlantic salmon. These reports consist of literature reviews documenting the life history and habitat requirements of the species, as well as food habits information and distribution and abundance information by life history stage. The species report for Atlantic salmon was developed by the Council, with information from NMFS, the U.S. Fish and Wildlife Service, and the Maine Atlantic Salmon Authority. These reports are provided in Appendix A. The information presented in the species reports was used to develop the EFH text descriptions for all species.

The text descriptions of essential fish habitat set the environmental parameters within which the map designations are considered. NMFS regulations within the Interim Final Rule require that the text description take precedence when the text and EFH maps differ. These text descriptions identify the habitat requirements for each species by life history
stage. They include the general geographic area(s) preferred by the species, the preferred substrate (if demersal), and ideal ranges of water temperature, depth, and salinity (where known). The descriptions reflect the best available information on the species' habitat requirements collected from the scientific literature and observations made during research surveys. Where information was available, the text descriptions also identify those bays and estuaries designated as EFH, based on the observed relative abundance of the species. For maps of the bays and estuaries considered by the Council, please refer to Appendix B.
Table 4: Council-managed species requiring EFH designations.*

<table>
<thead>
<tr>
<th>FMP</th>
<th>Species</th>
<th>Common Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multispecies (Groundfish)</td>
<td><em>Gadus morhua</em></td>
<td>Atlantic cod (official) rock cod</td>
</tr>
<tr>
<td>Multispecies</td>
<td><em>Glyptocephalus cynoglossus</em></td>
<td>witch flounder (official) gray sole Craig fluke pole flounder</td>
</tr>
<tr>
<td>Multispecies</td>
<td><em>Hippoglossoides platessoides</em></td>
<td>American plaice (official) American dab Canadian plaice long rough dab</td>
</tr>
<tr>
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<td>yellowtail flounder (official) rusty flounder</td>
</tr>
<tr>
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<td><em>Macrozoarces americanus</em></td>
<td>ocean pout (official) eelpout Congo eel muttonfish</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>Multispecies</td>
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</tr>
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<td>FMP</td>
<td>Species</td>
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<td><em>Lophius americanus</em></td>
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</tr>
<tr>
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<td>molligut</td>
</tr>
<tr>
<td></td>
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<td><em>Placopecten magellanicus</em></td>
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</tr>
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<td></td>
<td></td>
<td>giant scallop</td>
</tr>
<tr>
<td></td>
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<td>Digby scallop</td>
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<td>sardine</td>
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<tr>
<td></td>
<td></td>
<td>sperling</td>
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<tr>
<td></td>
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<td>black salmon</td>
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</table>

* Common names as listed in Bigelow, H.R. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv., Fish. Bull. 53. 577pp. The "official" common name is the one used by the NEFMC and is the name used in this document.
3.2 IDENTIFICATION OF ESSENTIAL FISH HABITAT

The map designations of essential fish habitat identify the geographic extent within which certain types of habitat are considered EFH. EFH must be designated according to the level of information available on the species distribution, abundance, and habitat-productivity relationships. The levels of information, as defined in the Interim Final Rule, are:

- **Level 1**: Presence / absence data are available for portions of the range of the species. At this level, only presence / absence data are available to describe the distribution of a species (or life history stage) in relation to potential habitats. In the event that distribution data are available for only portions of the geographic area occupied by a particular life history stage of a species, EFH can be inferred on the basis of distributions among habitats where the species has been found and on information about its habitat requirements and behavior.

- **Level 2**: Habitat-related densities are available. At this level, quantitative data (i.e., density or relative abundance) are available for the habitats occupied by a species of life history stage. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value. When assessing habitat value on the basis of fish densities in this manner, temporal changes in habitat availability and utilization should be considered.

- **Level 3**: Growth, reproduction, and survival rates within habitats are available. At this level, data are available on habitat-related growth, reproduction, and/or survival by life history stage. The habitats contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life history stage).

- **Level 4**: Production rates by habitat are available. At this level, data are available that directly relate the production rates of a species of life history stage to habitat type, quantity, and location. Essential habitats are those necessary to maintain fish production consistent with a sustainable fishery and the managed species’ contribution to a healthy ecosystem.

Table 5 displays the level of information available for each species' EFH designation. For most species, the best information consists of relative abundance and distribution data (Level 2) and presence / absence data (Level 1). In a few cases, some Level 3 information is available, but there is a definite lack of detailed and scientific information relating fish productivity to habitat type, quantity, quality and location. Guidance provided by NMFS in the Interim Final Rule suggests that when working only with Level 1 and Level 2 data, "the degree that a habitat is utilized is assumed to be indicative of habitat value." In other words, if all that is known is where the fish tend to be in relatively high concentrations, these areas are assumed to be the essential fish habitat. This is the approach the Council has adopted, using relative densities and areal extent to determine the EFH designations.
### Table 5: Sources and Levels of EFH Information *

<table>
<thead>
<tr>
<th>Species</th>
<th>eggs</th>
<th>larvae</th>
<th>juvenile</th>
<th>adult</th>
<th>spawners</th>
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</tr>
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<td>yellowtail flounder</td>
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<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

* The numbers represent the highest available level of information available for each life history stage. Level "0" indicates that there is very little information available for this life history stage. "N/A" indicates that this does not exist as a distinct life history stage for this species. Please see page 3 for an explanation of the information levels.
3.2.1 Sources of Information

There are several sources of distribution and abundance data used to develop the EFH
designations. The NMFS bottom trawl survey (1963 - 1997) and the NMFS Marine
Resources Monitoring, Assessment and Prediction (MARMAP) ichthyoplankton survey
(1977 - 1987) provide the best available information on the distribution and relative
abundance of Council-managed species in offshore waters. The bottom trawl survey is
used for juveniles and adults, and the MARMAP survey is used for eggs and larvae. The
Council used other sources of information on inshore areas, including the Massachusetts
inshore trawl survey (1978 - 1997), information from Long Island Sound (1990 - 1996),
and NOAA’s Estuarine Living Marine Resources (ELMR) program. Data on the
distribution and relative abundance of fish in other inshore areas, especially estuaries and
embayments, were not available in a timely manner in some cases. The Council also
considered information provided by the fishing industry, as well as several sources of
historical information. Information on the distribution and abundance of sea scallops was
obtained primarily from the NMFS sea scallop survey (1982 - 1997) and from
representatives of the scallop fishing industry. Information on the range and distribution
of Atlantic salmon was obtained primarily from the available literature. Detailed
descriptions of the surveys and databases used by the Council in the EFH designation
process, including the sampling protocols and methods, are provided in Appendix C. A
detailed discussion of the limitations associated with using these data and information
sources as the basis for designating EFH is provided in Appendix D.

3.2.2 ELMR Program Information

Used by the Council as the primary source of information on species distribution and
abundance in the bays and estuaries of New England and the Mid-Atlantic, NOAA’s
Estuarine Living Marine Resources (ELMR) program has been conducted jointly by the
Strategic Environmental Assessments (SEA) Division of NOAA’s Office of Ocean
Resources Conservation and Assessment (ORCA), NMFS, and other agencies and
institutions. The goal of this program is to develop a comprehensive information base on
the life history, relative abundance and distribution of fishes and invertebrates in estuaries
throughout the nation. The nationwide ELMR database was completed in 1994, and
includes information for 135 species found in 122 estuaries and coastal embayments.
The Jury et al. (1994) report summarizes information on the distribution and abundance
of 58 fish and invertebrate species in 17 North Atlantic estuaries. The Stone et al. (1994)
report summarizes information on the distribution and abundance of 61 fish and
invertebrate species in 14 Mid-Atlantic estuaries.

Most existing estuarine fisheries data cannot be compared among estuaries because of the
variable sampling strategies. In addition, existing research programs do not focus on how
groups of estuaries may be important for regional fishery management. The ELMR
program was developed to integrate fragments of information on many species and their
associated habitats into a useful, comprehensive and consistent format. The framework
employed for the ELMR program enables a consistent compilation and organization of all
available data on the distribution and abundance of fishes and invertebrates in estuaries.
For the New England region, thirteen north Atlantic estuaries were selected from the
National Estuarine Inventory (NEI) Data Atlas Volume I, and after discussions with several regional researchers, four additional estuaries were included. Although not every New England or mid-Atlantic estuary is addressed, thirty-one estuaries are included in the Jury et al. (1994) and Stone et al. (1994) reports:

- Passamaquoddy Bay
- Englishman/Machias Bays
- Narraguagus Bay
- Blue Hill Bay
- Penobscot Bay
- Muscongus Bay
- Damariscotta River
- Sheepscot River
- Kennebec/Androscoggin Rivers
- Casco Bay
- Saco River
- Wells Harbor
- Great Bay
- Merrimack River
- Massachusetts Bay
- Boston Harbor
- Cape Cod Bay
- Waquoit Bay
- Buzzards Bay
- Narragansett Bay
- Connecticut River
- Gardiners Bay
- Long Island Sound
- Great South Bay
- Hudson River/Raritan Bay
- Barnegat Bay
- New Jersey Inland Bays
- Delaware Bay
- Delaware Inland Bays
- Chincoteague Bay
- Chesapeake Bay

Project staff compiled species distribution and abundance information for these estuaries by conducting exhaustive literature searches and examining published and unpublished data sets. To complement the information from these quantitative studies, regional, state, and local biologists were interviewed for their knowledge of estuary/species-specific spatial and temporal distribution patterns and relative abundance levels based upon their experience and research. The final level of relative abundance assigned to a particular species was determined from the available data and expert review. To rank relative abundance, ELMR staff used the following categories:

- **Not present** -- species or life history stage not found, questionable data as to identification of species, and/or recent loss of habitat or environmental degradation suggests absence.

- **No information available** -- no existing data available, and after expert review it was determined that not even an educated guess would be appropriate. This category was also used if the limited data available were extremely conflicting and/or contradictory; in these cases, *no information available* actually describes a situation where the available information was indecipherable.

- **Rare** -- species is definitely present but not frequently encountered.

- **Common** -- species is frequently encountered but not in large numbers; does not imply a uniform distribution over a specific salinity zone.

- **Abundant** -- species is often encountered in substantial numbers relative to other species with similar life modes.

- **Highly abundant** -- species is numerically dominant relative to other species with similar life modes. The Council considers the *abundant* and *highly abundant* categories to be the same for the purposes of designating EFH.

For many well-studies species, quantitative data were used to estimate spatial and temporal distributions. For other species, however, reliable quantitative data were
limited. Therefore, nearly all information used in the reports were submitted to panels of local researchers, managers, and technicians for peer review based upon their knowledge of individual species within an estuary. More than 72 scientists and managers at 33 institutions were consulted (the ELMR reports list the individuals and their affiliations). An important aspect of the ELMR program, because it is based primarily on literature and consultations, was to determine the reliability of the available information. The reliability of available information varied between species, life stage, and estuary, due to differences in gear selectivity, difficulty in identifying larvae, difficulty in sampling various habitats, and the extent of sampling and analysis in particular studies. Data reliability was classified using the following categories:

- **Highly certain** -- considerable sampling data available. Distribution, behavior, and preferred habitats well documented within the estuary.
- **Moderately certain** -- some sampling data available for the estuary. Distribution, preferred habitat, and behavior well documented in similar estuaries.
- **Reasonable inference** -- little or no sampling data available. Information on distributions, ecology, and preferred habitats documented in similar estuaries.

The ELMR information, as presented, should be considered "Level 1" data, as defined in the Interim Final Rule. Guidance in the Interim Final Rule suggests that when working only with Level 1 data, "presence / absence data should be evaluated . . . to identify those habitat areas most commonly used by the species." As it relates to the information presented in the ELMR reports, estuaries where a particular species is abundant are assumed to be more commonly used than estuaries where a particular species is rare. More commonly used estuaries should be considered in the designation of essential fish habitat.

Several members of the Council's EFH Technical Team had direct involvement with the process for developing the ELMR information, either as interviewees or as reviewers. In their experience, all levels of data reliability provide sound information for use in determining the presence or absence of a species within an estuary. Information classified on the basis of *reasonable inference* may not be based on directed research to assess the abundance of a particular species within an estuary, but it does reflect the professional experience and personal knowledge of scientists and managers intimately involved with the species and estuaries in question. Information of a dubious nature, or information that is not verifiable would be categorized as *no information available* and the species would therefore not appear as *rare*, *common*, *abundant*, or *highly abundant* in an estuary.

The Council determined that the information presented in the ELMR reports met the qualifications of the Interim Final Rule for "Level 1" data, and as such, should be considered and incorporated into the EFH designation process. Although the NMFS ichthyoplankton and bottom trawl survey remained the primary source of information for designating EFH, the ELMR reports serve as "additional information."
Although the Council reserved the right to evaluate individually the appropriate EFH designations based on the ELMR information, the following provides a general guide for how the Council applied the information. For those species' life history stages for which the Council designated EFH based on the 100% alternative (i.e., EFH is designated as 100% of the range observed for the species' life history stage), all estuaries in which the species' life history stage is categorized as *rare*, *common*, *abundant*, or *highly abundant* were included in the EFH designation. For those species' life history stages for which the Council designated EFH based on the 90% alternative, all estuaries in which the species' life history stage is categorized as *common*, *abundant*, or *highly abundant* were included in the EFH designation. Species for which the 50% or 75% alternative was used, all estuaries in which the species' life history stage is categorized as *abundant* or *highly abundant* were included in the EFH designation.

### 3.2.3 EFH Alternatives

The alternatives considered by the Council are based on the relative densities of fish observations. For all species, a set of alternatives was developed for each of the major life history stages, with the exception of sea scallops, Atlantic salmon, and Atlantic halibut. Those stages include eggs, larvae, juveniles, and adults. The maps presenting the alternatives display the distribution and abundance data by ten minute squares of latitude and longitude. This is the most efficient and understandable spatial scale for use in this process because the NMFS distribution and abundance data were easily represented by ten minute squares and the data can be compared to other data sets, information from the fishing industry, and existing management measures. A map with the grid of ten minute squares can be viewed in Figure 4.

The Council used two methods for developing the EFH designations: one based on catch-per-unit-effort per ten minute square, and the other based on straight percentages of observed range. The catch-per-unit-effort method was used for all demersal life history stages (juveniles and adults of all species with the exception of Atlantic herring and Atlantic salmon). The percentage of observed range method was used for all planktonic life history stages (eggs and larvae of most species) and the juvenile and adult stages of the pelagic schooling Atlantic herring. The "observed range" for each species includes all areas where the species was observed by either the NMFS bottom trawl or MARMAP surveys.

Selection factors were applied to the bottom-trawl and ichthyoplankton survey databases to construct the data sets for the Council alternatives and EFH designation maps. The selection factors were recommended by NMFS Northeast Fisheries Science Center (NEFSC) scientists who collected and work with the data. Correction factors were used to standardize the bottom-trawl catch of various species due to variation in doors, trawls, and/or vessels among the surveys. Correction factors were applied to specific species (see Appendix C, Methods Report, Table 4). After the bottom-trawl and ichthyoplankton data were selected, the summarization process was the same. Data were assigned to a ten minute square based on the location of the starting point of the bottom-trawl or ichthyoplankton sample tow. Only those squares that had greater than three samples and one positive catch were selected. Catch data were transformed by taking the natural...
logarithm of the catch $[\ln(catch + 1)]$ and the mean of the transformed data was calculated for each ten minute square.

In analyzing the data for each species’ life stage using the catch-per-unit-effort method, each ten minute square throughout the survey area and included in the analysis was ranked from highest to lowest according to an index of the mean catch per unit of effort of the survey (i.e., the number of fish caught in each tow of the survey trawl). For each life history stage, the alternatives considered include: (1) the area that comprises the top 50% of catch per unit effort abundance index, (2) the area that comprises the top 75% of catch per unit effort abundance index, (3) the area that comprises the top 90% of catch per unit effort abundance index, (4) 100% of the observed range of the species, and (5) no EFH designation (the status quo option).

In analyzing the data for each species’ life stage using the straight area percentage method, each ten minute square throughout the survey area and included in the analysis was also ranked from highest to lowest according to an index of the mean catch per unit of effort of the survey. In this case, however, the alternatives represent the percentage of the overall area (the observed range) rather than a percentage of the catch-per-unit effort. For each life history stage, the alternatives considered include: (1) the area that comprises the top 50% of the observed range, (2) the area that comprises the top 75% of the observed range, (3) the area that comprises the top 90% of the observed range, (4) 100% of the observed range of the species, and (5) no EFH designation (the status quo option).

The former method was used because it accurately reflected that for most demersal life history stages, the population is rather concentrated in some portions its overall range, especially where environmental conditions such as habitat and prey resources were most favorable, and it is less concentrated in other portions of its overall range where environmental conditions are not as favorable. Clearly, EFH should be designated where environmental conditions, especially habitat, are most favorable, thus the highest percentages of the catch-per-unit-effort index were a suitable proxy for identifying these areas.

In the case of the planktonic life history stages and the pelagic schooling nature of juvenile and adult Atlantic herring, this method did not necessary capture the “area” most favorable to the species. Planktonic eggs tend to be clumped only immediately after a spawning event, and they soon after disperse rapidly and move with the prevailing currents. Currents and other oceanographic phenomenon tend to move and shift around the concentrations of planktonic eggs and larvae, and chance plays a large role in the eggs and larvae ending up in areas of the species’ range where environmental conditions are most favorable. Other factors related to the sampling methods for these life stages also contribute to the catch-per-unit-effort method not being as appropriate (see Appendices C and D). The straight percentage method was used in these cases as a more inclusive process to better represent the areas where the species tended to be.
Figure 4: Map of Ten Minute Squares
Figure 5 illustrates the comparison between these two related methods, using haddock juveniles as an example. In this case, 50% of the CPUE index is limited to 14% of the observed range and 90% of the CPUE index is limited to 54% of the observed range.

The no action or no EFH designation alternative was considered, but according to the Sustainable Fisheries Act, the Council is required to designate EFH for all managed species; thus, this alternative was not considered a valid option. For each life history stage of each species, the Council considered the remaining alternatives, selecting the EFH designation for each individually. The Council employed the most consistent approach possible, given the variety of species and unique characteristics of many of the life history stages and the limitations of the available data and information considered.

The Council's approach was focused on designating the smallest area possible that accounted for the majority of the observed catch, taking into account the habitat requirements of the species and any areas known to be important for sustaining the fishery. The Council considered the status of the resource, and was more conservative with those species considered overfished. The Council also considered the historic range of the species, including areas of historic importance, where appropriate. In some cases, the Council used a proxy to determine the most appropriate EFH designation for certain life history stages. This was done by applying the range of one life history stage as the EFH designation for another stage. The Council most often used a proxy designation when information was not available for a particular life history stage, but also used a proxy on occasion when the observed range of a particular life history stage did not accurately represent the true range.
The EFH designation for Atlantic salmon used a different approach. The unique life history characteristics of Atlantic salmon and the information available required a different set of alternatives, based not on relative abundance in any one ten minute square, but rather on the status of the populations of salmon within the rivers of New England. There were five categories of rivers considered for EFH designation by the Council: unique rivers (those currently part of the Atlantic salmon distinct population segment (DPS)); candidate rivers (those being considered for inclusion in the DPS); restoration rivers (those with active restoration projects); present rivers (those currently supporting Atlantic salmon); and, historic rivers (those that supported Atlantic salmon at one time but not at the present time).

The habitat description and identification for a managed species is based on the biological requirements and the distribution of the species. For all species, this includes a combination of state, federal, and international waters. According to the regulations, EFH can only be designated within U.S. federal or state waters. Although there may be areas outside of U.S. waters which are very important to Council-managed species, EFH can not be designated in Canadian waters or on the high seas. In cases where the range of a species extends into waters managed by the Mid-Atlantic Fishery Management Council (MAFMC), the NEFMC has designated EFH as long as the species is managed under a New England Fishery Management Council FMP. Accordingly, the maps representing the alternatives considered by the Council (provided in Section 12.3.3 of the Environmental Assessment) include those ten minute squares in Canadian waters where each species was caught in the NMFS surveys, but the actual EFH designations stop at the U.S - Canada boundary. The Council stresses that in many cases, habitat located in Canadian waters may be just as important, if not more important, than the habitat located in U.S. waters. The Council urges the Canadian government to examine this information and take complementary measures to ensure the adequate protection of this valuable habitat.

Quite often, the EFH designations appear quite patchy in spatial distribution. While this is normal in natural systems, to some extent this patchy distribution was based not on the natural distribution of the species, but on the limitations of the sampling protocols. Once the proposed designations were completed, including whatever additional information was available (ELMR, inshore surveys, fishing industry, landings, historical, etc.), the Council chose to also include any empty ten minute squares surrounded by either seven or eight "filled in" ten minute squares. This approach "smoothes" the designations, reducing to some degree the patchy nature of the EFH designations. For instance, there appeared certain areas where quite large expanses of EFH surrounded a single empty ten minute square. This may have resulted from the ten minute square not being sampled enough to be included in the analysis, or may have resulted from some topographic feature that prevented the survey gear from operating efficiently. Including these areas in the EFH designations assumes that they are important to the species. No ten minute squares were eliminated from the EFH designations in this process.
3.2.4 Areas Not Designated EFH

Certain geographic regions were not represented in the data considered by the Council, such as near shore waters of Maine, eastern Long Island, and smaller estuaries. These areas, therefore, have not been considered in the EFH designation process. This does not mean that they are not potentially important, but rather they represent data and information gaps. There is a need for information on the relative abundance of managed species in all areas that are not surveyed systematically. As information becomes available on these areas, the Council will consider including them in the EFH designations of the appropriate species. The Council will also consider whether certain near shore areas that represent data gaps should be designated EFH based on identified EFH in adjacent or nearby areas that share similar environmental characteristics.

3.3 HABITAT AREAS OF PARTICULAR CONCERN

According to the language of the Interim Final Rule, EFH that is judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation, should be identified as "habitat areas of particular concern" (HAPC) to help provide additional focus for conservation efforts. The following provisions of the Interim Final Rule provide guidance for habitat areas of particular concern:

(6) (ii) Cumulative impacts from fishing. In addressing the impacts of fishing on EFH, Councils should also consider the cumulative impacts of multiple fishing practices and non-fishing activities on EFH, especially, on habitat areas of particular concern. Habitats that are particularly vulnerable to specific fishing equipment types should be identified for possible designation as habitat areas of particular concern.

(9) Identification of habitat areas of particular concern. FMPs should identify habitat areas of particular concern within EFH. In determining whether a type, or area of EFH is a habitat area of particular concern, one or more of the following criteria must be met:

(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.

(iv) The rarity of the habitat type.

The intent of the habitat areas of particular concern designation is to identify those areas that are known to be important to species which are in need of additional levels of protection from adverse impacts. Management implications do result from their identification. Designation of habitat areas of particular concern is intended to determine what areas within EFH should receive more of the Council's and NMFS' attention when...
providing comments on federal and state actions, and in establishing higher standards to protect and/or restore such habitat. Certain activities should not be located in areas identified as habitat areas of particular concern due to the risk to the habitat. Habitats that are at greater risk to impacts, either individual or cumulative, including impacts from fishing, may be appropriate for this classification. Habitats that are limited in nature or those that provide critical refugia (such as sanctuaries or preserves) may also be appropriate. General concurrences may be granted for activities within habitat areas of particular concern; however, greater scrutiny is necessary prior to approval of the general concurrence.

Following a review of the scientific literature for information on areas deserving special attention or species with particular habitat associations, the Council has designated an area on Georges Bank as an HAPC for juvenile Atlantic cod (Figure 6). Considering the unique habitat associations and requirements of Atlantic salmon, the Council has designated the habitat of eleven rivers in Maine as HAPCs for Atlantic salmon (Figure 7). The Council may consider designating additional habitat areas of particular concern in the future. Additional designations may be based on existing or developing knowledge of species-habitat associations, the unique characteristics of a particular habitat type, the threats to sensitive habitats, or the importance of an area to multiple species.

### 3.3.1 Atlantic cod HAPC

Several sources document the importance of gravel/cobble substrate to the survival of newly settled juvenile cod (Lough et al. 1989; Valentine and Lough 1991; Gotceitas and Brown 1993; Tupper and Boutilier 1995; Valentine and Schmuck 1995). A substrate of gravel or cobble allows sufficient space for newly settled juvenile cod to find shelter and avoid predation (Lough et al. 1989; Valentine and Lough 1991; Gotceitas and Brown 1993; Tupper and Boutilier 1995; Valentine and Schmuck 1995). Particular life history stages or transitions are sometimes considered "ecological bottlenecks" if there are extremely high levels of mortality associated with the life history stage or transition. Extremely high mortality rates attendant to post-settlement juvenile cod are attributed to high levels of predation (Tupper and Boutilier 1995). Increasing the availability of suitable habitat for post-settlement juvenile cod could ease the bottleneck, increasing juvenile survivorship and recruitment into the fishery. For these reasons, areas with a gravel/cobble substrate meet the first criterion for habitat areas of particular concern.

Specific areas on the northern edge of Georges Bank have been extensively studied and identified as important areas for the survival of juvenile cod (Lough et al. 1989; Valentine and Lough 1991; Valentine and Schmuck 1995). These studies provide reliable information on the location of the areas most important to juvenile cod and the type of substrate found in those areas. These areas have also been studied to determine the effects of bottom fishing on the benthic megafauna (Collie et al. 1996; Collie et al. 1997). Gravel/cobble substrates not subject to fishing pressure support thick colonies of emergent epifauna, but bottom fishing, especially scallop dredging, reduces habitat complexity and removes much of the emergent epifauna (Collie et al. 1996; Collie et al. 1997). Acknowledging that a single tow of a dredge across pristine habitat will have few long-term effects, Collie et al. (1997) focus on the cumulative effects and intensity of
trawling and dredging as responsible for potential long-term changes in benthic communities. For these reasons, the identified area on the northern edge of Georges Bank meets the second criterion, as well as the cumulative effects consideration, for designation as a habitat area of particular concern.

Collie et al. (1997) also describe the relative abundance of several other species such as shrimps, polychaetes, brittle stars, and mussels in the undisturbed sites. These species are found in association with the emergent epifauna (bryozoans, hydroids, worm tubes) prevalent in the undisturbed areas. Several studies of the food habits of juvenile cod identify these associated species as important prey items (Hacunda 1981; Lilly and Parsons 1991; Witman and Sebens 1992; Casas and Paz 1994; NEFSC 1998). These areas provide two important ecological functions for post-settlement juvenile cod relative to other areas: increased survivability and readily available prey. These areas are also particularly vulnerable to adverse impacts from mobile fishing gear.

### 3.3.2 Atlantic salmon HAPC

Seven small, coastal drainages located in the Downeast and midcoast sections of Maine hold the last remaining populations of native Atlantic salmon in the United States (MASA and USFWS 1996). These important rivers are the Dennys, Machias, East Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot. The U.S. Fish and Wildlife Service (USFWS) and NMFS have determined that these rivers represent one distinct population segment (DPS). A DPS is defined as a population of vertebrates that is discrete and ecologically significant. Four other rivers in Maine -- the Kennebec, Penobscot, St. Croix, and Tunk Stream -- are being considered for possible inclusion in the DPS.

By supporting the only remaining U.S. populations of naturally spawning Atlantic salmon that have historic river-specific characteristics, these rivers provide an important ecological function. These river populations harbor an important genetic legacy that is vital to the persistence of these populations and to the continued existence of the species in the United States. Unfortunately the habitat of these rivers is susceptible to a variety of human-induced threats, from dam construction and hydropower operations to logging, agriculture, and aquaculture activities. Human activities can threaten the ability of Atlantic salmon to migrate upriver to the spawning habitat, the quality and quantity of the spawning and rearing habitat, and also the genetic integrity of the native populations contained in the rivers. The habitat of these rivers serves two very important purposes in terms of being habitat areas of particular concern: (1) they provide a unique and important ecological function; and, (2) they are sensitive to human-induced environmental degradation. Accordingly, the rivers meet at least two criteria for designation as habitat areas of particular concern.
Figure 6: Habitat Area of Particular Concern for Juvenile Atlantic Cod

The shaded areas represent Closed Areas I and II, as indicated.

The darkened area within Closed Area II represents the Habitat Area of Particular Concern for juvenile Atlantic cod.
These eleven rivers in Maine have been designated as "habitat areas of particular concern" for Atlantic salmon, based on the importance of the habitat of these rivers in supporting unique and important populations of Atlantic salmon in the United States.
3.4 EFH TEXT DESCRIPTIONS AND MAP DESIGNATIONS

For each species currently managed by the Council this section includes a one-page text description of the essential fish habitat for each life history stage, a table identifying those bays and estuaries included in the EFH designation (based on information provided in NOAA's ELMR reports), and a series of maps representing the Council's EFH designs for each life history stage. The EFH maps reflect all information included in the Council's designations, including the ELMR bays and estuaries, other inshore data, the historic range of the species, areas identified by the fishing industry, and those ten minute squares filled in to "smooth" the designations. The captions accompanying maps for the EFH designations describe the information reflected in those designations and provide the Council's rationale for selecting the preferred alternatives. The sets of maps representing the alternative designations from which the Council chose are provided in Section 12.2.3 of the Environmental Assessment. The sets of maps for the other alternatives include only the "raw" distributions as reflected in the NMFS bottom trawl and MARMAP surveys.
Essential Fish Habitat Description

Atlantic cod (Gadus morhua)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined the Gulf of Maine stock of cod is considered overfished, based on the fishing mortality rate. The Georges Bank stock of cod is not considered overfished, also based on the fishing mortality rate associated with this stock. For both stocks of cod, essential fish habitat is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 1.1 - 1.4 and in the accompanying table and meet the following conditions:

**Eggs:** Surface waters around the perimeter of the Gulf of Maine, Georges Bank, and the eastern portion of the continental shelf off southern New England as depicted in Figure 1.1. Generally, the following conditions exist where cod eggs are found: sea surface temperatures below 12° C, water depths less than 110 meters, and a salinity range from 32 - 33‰. Cod eggs are most often observed beginning in the fall, with peaks in the winter and spring.

**Larvae:** Pelagic waters of the Gulf of Maine, Georges Bank, and the eastern portion of the continental shelf off southern New England as depicted in Figure 1.2. Generally, the following conditions exist where cod larvae are found: sea surface temperatures below 10° C, waters depths from 30 - 70 meters, and a salinity range from 32 - 33‰. Cod larvae are most often observed in the spring.

**Juveniles:** Bottom habitats with a substrate of cobble or gravel in the Gulf of Maine, Georges Bank, and the eastern portion of the continental shelf off southern New England as depicted in Figure 1.3. Generally, the following conditions exist where cod juveniles are found: water temperatures below 20° C, depths from 25 - 75 meters, and a salinity range from 30 - 35‰.

**Adults:** Bottom habitats with a substrate of rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Delaware Bay as depicted in Figure 1.4. Generally, the following conditions exist where cod adults are found: water temperatures below 10° C, depths from 10 - 150 meters, and a wide range of oceanic salinities.

**Spawning Adults:** Bottom habitats with a substrate of smooth sand, rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Delaware Bay as depicted
in Figure 1.4. Generally, the following conditions exist where spawning cod adults are found: water temperatures below 10°C, depths from 10 - 150 meters, and a wide range of oceanic salinities. Cod are most often observed spawning during fall, winter, and early spring.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
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<tr>
<th>Estuaries and Embayments</th>
<th>Eggs</th>
<th>Larvae</th>
<th>Juvenile</th>
<th>Adult</th>
<th>Spawning Adults</th>
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S = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

M = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

F = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Figure 1.1: The EFH designation for Atlantic cod eggs is based upon a combination of alternative 3 for juvenile Atlantic cod plus alternative 3 for Atlantic cod eggs within the range of juvenile cod. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting Atlantic cod eggs at a "common" or "abundant" level. This approach was selected because the data on the distribution of cod eggs include areas believed to be not conducive to their survival. Eggs that occur south of Long Island are either passively transported southward by currents or spawned by fish on the southern edge of the range and the environmental conditions in this area are believed to be not suitable for survival. The component of the adult cod population in this area is migratory in nature; thus, these eggs do not contribute to this population. The light shading represents the entire observed range of Atlantic cod eggs.
Essential Fish Habitat
Atlantic cod (*Gadus morhua*) Larvae

Figure 1.2: The EFH designation for Atlantic cod larvae is based upon a combination of alternative 3 for juvenile Atlantic cod plus alternative 3 for Atlantic cod larvae within the range of juvenile cod. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting Atlantic cod larvae at a "common" or "abundant" level. This approach was selected because the data on the distribution of cod larvae include areas believed to be not conducive to their survival. Eggs and larvae that occur south of Long Island are either passively transported southward by currents or spawned by fish on the southern edge of the range and the environmental conditions in this area are believed to be not suitable for survival. The component of the adult cod population in this area is migratory in nature; thus, these larvae do not contribute to this population. The light shading represents the entire observed range of Atlantic cod larvae.
Figure 1.3: The EFH designation for juvenile Atlantic cod is based upon alternative 3 for cod juveniles plus information from the fishing industry. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting juvenile Atlantic cod at a "common" or "abundant" level and information from the Massachusetts Inshore Trawl Survey. The other alternatives were not selected because they either include too little area (less than half the range of this overfished species), or include areas where cod occur in relatively low concentrations. The small area highlighted on the northern edge of Georges Bank represents the "habitat area of particular concern" designation for juvenile Atlantic cod (see Section 3.3.1). The light shading represents the entire observed range of Atlantic cod juveniles.
Essential Fish Habitat
Atlantic cod (Gadus morhua) Adults

Figure 1.4: The EFH designation for adult Atlantic cod is based upon alternative 3 for cod adults plus areas identified as important spawning grounds and information from the fishing industry. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting adult Atlantic cod at a "common" or "abundant" level. The shaded areas south of Massachusetts and Rhode Island and along the coast of New Jersey and Delaware were selected for EFH designation based on their historical importance for a portion of the adult population that migrates to this area for feeding in the winter. The other alternatives were not selected because they either include too little area (less than half the range of this overfished species), or include areas where cod occur in relatively low concentrations. The light shading represents the entire observed range of Atlantic cod adults.
Essential Fish Habitat Description

Haddock (*Melanogrammus aeglefinus*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined the Georges Bank stock of haddock is neither currently overfished nor approaching an overfished condition. The report also concluded that there is not enough information to determine if the Gulf of Maine stock is overfished or approaching an overfished condition. For both stocks of haddock, essential fish habitat is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 2.1 - 2.4 and in the accompanying table and meet the following conditions:

**Eggs:** Surface waters over Georges Bank southwest to Nantucket Shoals and the coastal areas of the Gulf of Maine as depicted in Figure 2.1. Generally, the following conditions exist where haddock eggs are found: sea surface temperatures below 10° C, water depths from 50 - 90 meters, and salinity ranges from 34 - 36‰. Haddock eggs are most often observed during the months from March to May, April being most important.

**Larvae:** Surface waters over Georges Bank southwest to the middle Atlantic south to Delaware Bay as depicted in Figure 2.2. Generally, the following conditions exist where haddock larvae are found: sea surface temperatures below 14° C, water depths from 30 - 90 meters, and salinity ranges from 34 - 36‰. Haddock larvae are most often observed in these areas from January through July with peaks in April and May.

**Juveniles:** Bottom habitats with a substrate of pebble gravel on the perimeter of Georges Bank, the Gulf of Maine, and the middle Atlantic south to Delaware Bay as depicted in Figure 2.3. Generally, the following conditions exist where haddock juveniles are found: water temperatures below 11° C, depths from 35 - 100 meters, and a salinity range from 31.5 - 34‰.

**Adults:** Bottom habitats with a substrate of broken ground, pebbles, smooth hard sand and smooth areas between rocky patches on Georges Bank and the eastern side of Nantucket Shoals, and throughout the Gulf of Maine, plus additional area of Nantucket Shoals and the Great South Channel inclusive of the historic range as depicted in Figure 2.4. This additional area more accurately reflects historic patterns of distribution and abundance. Generally, the following conditions exist where haddock adults are found: water temperatures below 7° C, depths from 40 - 150 meters, and a salinity range from 31.5 - 35‰.
**Spawning Adults:** Bottom habitats with a substrate of pebble gravel or gravelly sand on Georges Bank, Nantucket Shoals, along the Great South Channel, and throughout the Gulf of Maine, plus additional area inclusive of the historic range as depicted in Figure 2.4. Generally, the following conditions exist where spawning haddock adults are found: water temperatures below 6°C, depths from 40 - 150 meters, and a salinity range from 31.5 - 34‰. Haddock are observed spawning most often during the months January to June.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council notes the historic importance of areas where haddock were once commonly found (Rich 1929). The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
# EFH Designation of Estuaries and Embayments

## Haddock (Melanogrammus aeglefinus)

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<th>Estuaries and Embayments</th>
<th>Eggs</th>
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<th>Juveniles</th>
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S = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

M = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

F = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Essential Fish Habitat
Haddock (*Melanogrammus aeglefinus*) Eggs

Figure 2.1: The EFH designation for haddock eggs is based upon alternative 4 for haddock eggs. In addition, this designation includes those bays and estuaries identified in the NOAA ELMR program as supporting haddock eggs at the "rare", "common", or "abundant" level. This alternative was selected to be as inclusive as possible, given the distribution of haddock eggs. The light shading represents the entire observed range of haddock eggs.
Essential Fish Habitat
Haddock (*Melanogrammus aeglefinus*) Larvae

Figure 2.2: The EFH designation for haddock larvae is based upon alternative 4 for haddock larvae. In addition, this designation includes those bays and estuaries identified in the NOAA ELMR program as supporting haddock larvae at the "rare", "common", or "abundant" level. This alternative was selected to be as inclusive as possible, given the distribution of haddock larvae. The light shading represents the entire observed range of haddock larvae.
Figure 2.3: The EFH designation for juvenile haddock is based upon alternative 3 for haddock juveniles. This alternative was selected because it included all areas where haddock juveniles were observed in relatively high concentrations, but did not include areas where they occurred in low concentrations. The light shading represents the entire observed range of juvenile haddock.
Essential Fish Habitat
Haddock (Melanogrammus aeglefinus) Adults

Figure 2.4: The EFH designation for adult haddock is based upon alternative 3 for haddock adults. In addition, this designation includes a portion of the historic range and known spawning areas to more accurately reflect traditional patterns of distribution and abundance. This alternative was selected because it included all areas where haddock adults were observed in relatively high concentrations, but did not include areas where they occurred in low concentrations. Areas of historic importance were included to ensure that potentially important historic habitat was reflected in the EFH designation. The light shading represents the entire observed range of adult haddock.
Essential Fish Habitat Description

Atlantic herring (*Clupea harengus*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined Atlantic herring is not currently overfished. This determination is based on the fishing mortality rate. Essential Fish Habitat for Atlantic herring is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 3.1 - 3.4 and in the accompanying table and meet the following conditions:

**Eggs:** Bottom habitats with a substrate of gravel, sand, cobble and shell fragments, but also on aquatic macrophytes, in the Gulf of Maine and Georges Bank as depicted in Figure 3.1. Eggs adhere to the bottom, forming extensive egg beds which may be many layers deep. Generally, the following conditions exist where Atlantic herring eggs are found: water temperatures below 15°C, depths from 20 - 80 meters, and a salinity range from 32 - 33‰. Herring eggs are most often found in areas of well-mixed water, with tidal currents between 1.5 and 3.0 knots. Atlantic herring eggs are most often observed during the months from July through November.

**Larvae:** Pelagic waters in the Gulf of Maine, Georges Bank, and southern New England that comprise 90% of the observed range of Atlantic herring larvae as depicted in Figure 3.2. Generally, the following conditions exist where Atlantic herring larvae are found: sea surface temperatures below 16°C, water depths from 50 - 90 meters, and salinities around 32‰. Atlantic herring larvae are observed between August and April, with peaks from September through November.

**Juveniles:** Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras as depicted in Figure 3.3. Generally, the following conditions exist where Atlantic herring juveniles are found: water temperatures below 10°C, water depths from 15 - 135 meters, and a salinity range from 26 - 32‰.

**Adults:** Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras as depicted in Figure 3.4. Generally, the following conditions exist where Atlantic herring adults are found: water temperatures below 10°C, water depths from 20 - 130 meters, and salinities above 28‰.

**Spawning Adults:** Bottom habitats with a substrate of gravel, sand, cobble and shell fragments, but also on aquatic macrophytes, in the Gulf
of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay as depicted in Figure 3.4. Generally, the following conditions exist where spawning Atlantic herring adults are found: water temperatures below 15°C, depths from 20 - 80 meters, and a salinity range from 32 - 33‰. Herring eggs are spawned in areas of well-mixed water, with tidal currents between 1.5 and 3.0 knots. Atlantic herring are most often observed spawning during the months from July through November.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
### EFH Designation of Estuaries and Embayments

**Atlantic herring** (*Clupea harengus*)

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<th>Estuaries and Embayments</th>
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<th>Juveniles</th>
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**S** = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

**M** = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary \((0.5 < \text{salinity} < 25.0‰)\).

**F** = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary \((0.0 < \text{salinity} < 0.5‰)\).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Essential Fish Habitat
Atlantic herring (Clupea harengus) Eggs

Figure 3.1: The EFH designation for Atlantic herring eggs represents 100% of the known Atlantic herring egg beds. These egg beds were identified based on a review of all available information on the current and historical herring egg bed locations. All known herring beds were identified for EFH designation to be as inclusive as possible for this critical life history stage, and because all known egg beds only represent a portion of all herring egg sites. In addition, this designation includes those bays and estuaries identified in the NOAA ELMR program as supporting herring eggs at the "rare", "common", or "abundant" level. There were no specific alternatives considered by the Council, although the Council did have the option to designate fewer than 100% of the known herring egg beds.
Figure 3.2: The EFH designation for Atlantic herring larvae is based upon alternative 3 for herring larvae. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting Atlantic herring larvae at a "common" or "abundant" level. This alternative was selected to include all areas where herring larvae are found in relatively high concentrations, but not those areas where herring larvae are found in relatively very low concentrations. The light shading represents the entire observed range of Atlantic herring larvae.
Figure 3.3: The EFH designation for juvenile Atlantic herring is based upon alternative 2 for juvenile herring, plus areas of relatively high concentrations of juvenile herring from the State of Massachusetts inshore trawl survey. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting juvenile Atlantic herring at a "common" or "abundant" level. This alternative was selected to ensure inclusion of all areas where herring occur in relatively high concentrations. The other alternatives were not selected because they either include too little area (less than half of the range of the species) or include areas where herring occur in relatively low concentrations. The light shading represents the entire observed range of juvenile Atlantic herring.
Figure 3.4: The EFH designation for adult Atlantic herring is based upon alternative 2 for adult herring, combined with the 50% alternative of the 1997 recorded catch data. This designation also includes information from the fishing industry and those bays and estuaries identified by the NOAA ELMR program as supporting adult Atlantic herring at a "common" or "abundant" level. This alternative was selected to ensure inclusion of all areas where herring occur in relatively high concentrations. The other alternatives were not selected because they either include too little area (less than half of the range of the species) or include areas where herring occur in relatively low concentrations. The light shading represents the entire observed range of adult Atlantic herring.
Essential Fish Habitat Description
Monkfish (*Lophius americanus*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined monkfish is currently overfished. This determination is based on an assessment of stock size. Essential Fish Habitat for monkfish is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 4.1 - 4.4 and meet the following conditions:

**Eggs:** Surface waters of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras, North Carolina as depicted in Figure 4.1. Generally, the following conditions exist where monkfish egg veils are found: sea surface temperatures below 18° C and water depths from 15 - 1000 meters. Monkfish egg veils are most often observed during the months from March to September.

**Larvae:** Pelagic waters of the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras, North Carolina as depicted in Figure 4.2. Generally, the following conditions exist where monkfish larvae are found: water temperatures 15° C and water depths from 25 - 1000 meters. Monkfish larvae are most often observed during the months from March to September.

**Juveniles:** Bottom habitats with substrates of a sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud along the outer continental shelf in the middle Atlantic, the mid-shelf off southern New England, and all areas of the Gulf of Maine as depicted in Figure 4.3. Generally, the following conditions exist where monkfish juveniles are found: water temperatures below 13° C, depths from 25 - 200 meters, and a salinity range from 29.9 - 36.7‰.

**Adults:** Bottom habitats with substrates of a sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud along the outer continental shelf in the middle Atlantic, the mid-shelf off southern New England, along the outer perimeter of Georges Bank and all areas of the Gulf of Maine as depicted in Figure 4.4. Generally, the following conditions exist where monkfish adults are found: water temperatures below 15° C, depths from 25 - 200 meters, and a salinity range from 29.9 - 36.7‰.

**Spawning Adults:** Bottom habitats with substrates of a sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud along the outer continental shelf in the middle Atlantic, the mid-shelf off southern New England, along the outer perimeter of Georges Bank and all areas of the Gulf of Maine as depicted in Figure 4.4. Generally, the following conditions exist where spawning monkfish adults are found: water
temperatures below 13° C, depths from 25 - 200 meters, and a salinity range from 29.9 - 36.7‰. Monkfish are observed spawning most often during the months from February to August.

The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
Figure 4.1: The EFH designation for monkfish eggs is based upon alternative 4 for monkfish larvae in combination with alternative 4 for monkfish adults. Due to the difficulty of sampling monkfish eggs, the combination of larvae and adults was used as a proxy. This alternative was selected to be as conservative as possible given the lack of information on the distribution of monkfish eggs. The light shading represents the entire observed range of adult monkfish.
Figure 4.2: The EFH designation for monkfish larvae is based upon alternative 4 for monkfish larvae in combination with alternative 4 for monkfish adults. Due to the somewhat patchy and sparse distribution of monkfish larvae observations, the combination of larvae and adults was used as a proxy. This alternative was selected to be as conservative as possible given the patchy nature of the distribution of monkfish larvae. The light shading represents the entire observed range of adult monkfish.
Figure 4.3: The EFH designation for juvenile monkfish is based upon alternative 3 for monkfish juveniles. This alternative was selected because it included all areas where monkfish juveniles were observed in relatively high concentrations, but did not include areas where they occurred in low concentrations. The light shading represents the entire observed range of juvenile monkfish.
Figure 4.4: The EFH designation for adult monkfish is based upon alternative 3 for monkfish adults. This alternative was selected because it included all areas where monkfish adults were observed in relatively high concentrations, but did not include areas where they occurred in low concentrations. The light shading represents the entire observed range of adult monkfish.
Essential Fish Habitat Description
Ocean pout (*Macrozoarces americanus*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined ocean pout is not currently overfished. This determination is based on an assessment of stock level. Essential Fish Habitat for ocean pout is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 5.1 - 5.4 and in the accompanying table and meet the following conditions:

**Eggs:** Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay as depicted in Figure 5.1. Due to low fecundity, relatively few eggs (< 4200) are laid in gelatinous masses, generally in hard bottom sheltered nests, holes, or crevices where they are guarded by either female or both parents. Generally, the following conditions exist where ocean pout eggs are found: water temperatures below 10°C, depths less than 50 meters, and a salinity range from 32 - 34‰. Ocean pout egg development takes two to three months during late fall and winter.

**Larvae:** Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay as depicted in Figure 5.2. Larvae are relatively advanced in development and are believed to remain in close proximity to hard bottom nesting areas. Generally, the following conditions exist where ocean pout larvae are found: sea surface temperatures below 10°C, depths less than 50 meters, and salinities greater than 25‰. Ocean pout larvae are most often observed from late fall through spring.

**Juveniles:** Bottom habitats, often smooth bottom near rocks or algae in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay as depicted in Figure 5.3. Generally, the following conditions exist where ocean pout juveniles are found: water temperatures below 14°C, depths less than 80 meters, and salinities greater than 25‰.

**Adults:** Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay as depicted in Figure 5.4. Generally, the following conditions exist where ocean pout adults are found: water temperatures below 15°C, depths less than 110 meters, and a salinity range from 32 - 34‰.

**Spawning Adults:** Bottom habitats with a hard bottom substrate, including artificial reefs and shipwrecks, in the Gulf of Maine, Georges
Bank, southern New England and the middle Atlantic south to Delaware Bay as depicted in Figure 5.4. Generally, the following conditions exist where spawning ocean pout adults are found: water temperatures below $10^\circ$ C, depths less than 50 meters, and a salinity range from 32 - 34‰. Ocean pout spawn from late summer through early winter, with peaks in September and October.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
**EFH Designation of Estuaries and Embayments**  
*Ocean pout* (*Macrozoarces americanus*)

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<th>Estuaries and Embayments</th>
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M = The EFH designation for this species includes the mixing water/brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

F = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Figure 5.1: The EFH designation for ocean pout eggs is based upon the combination of alternative 3 for ocean pout juveniles and alternative 3 for ocean pout adults, in addition to those bays and estuaries identified by the NOAA ELMR program as supporting ocean pout eggs at a "common" or "abundant" level. This designation also includes areas of relatively high concentrations of ocean pout from the State of Massachusetts inshore trawl survey and the Connecticut Long Island Sound survey. Ocean pout eggs are found only in demersal nests, thus eggs are not sampled effectively with the MARMAP ichthyoplankton survey. The distribution of ocean pout juveniles and adults serves as a proxy for actual distribution data on eggs. This alternative was selected as most representative of where ocean pout eggs are likely to be found in relatively high concentrations. The light shading represents the entire observed range of ocean pout adults.
Figure 5.2: The EFH designation for ocean pout larvae is based upon the combination of alternative 3 for ocean pout juveniles and alternative 3 for ocean pout adults, in addition to those bays and estuaries identified by the NOAA ELMR program as supporting ocean pout larvae at a "common" or "abundant" level. This designation also includes areas of relatively high concentrations of ocean pout from the State of Massachusetts inshore trawl survey and the Connecticut Long Island Sound survey. Ocean pout larvae remain in close proximity with the nests, thus larvae are not sampled effectively with the MARMAP ichthyoplankton survey. The distribution of ocean pout juveniles and adults serves as a proxy for actual distribution data on larvae. This alternative was selected as most representative of where ocean pout larvae are likely to be found in relatively high concentrations. The light shading represents the entire observed range of ocean pout adults.
Essential Fish Habitat
Ocean pout (*Macrozoarces americanus*) Juveniles

Figure 5.3: The EFH designation for juvenile ocean pout is based upon alternative 3 for juvenile ocean pout, plus those bays and estuaries identified by the NOAA ELMR program as supporting juvenile ocean pout at a "common" or "abundant" level. This designation also includes areas of relatively high concentrations of ocean pout from the State of Massachusetts inshore trawl survey and the Connecticut Long Island Sound survey. This alternative was selected to be inclusive of most areas where ocean pout occur in relatively high concentrations. The light shading represents the entire observed range of juvenile ocean pout.
Figure 5.4: The EFH designation for adult ocean pout is based upon alternative 3 for adult ocean pout, plus those bays and estuaries identified by the NOAA ELMR program as supporting adult ocean pout at a "common" or "abundant" level. This designation also includes areas of relatively high concentrations of ocean pout from the State of Massachusetts inshore trawl survey and the Connecticut Long Island Sound survey. This alternative was selected to be inclusive of most areas where ocean pout occur in relatively high concentrations. The light shading represents the entire observed range of adult ocean pout.
Essential Fish Habitat Description

American plaice (*Hippoglossoides platessoides*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined American plaice is currently overfished. This determination is based on the fishing mortality rate. Essential Fish Habitat for American plaice is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 6.1 - 6.4 and in the accompanying table and meet the following conditions:

**Eggs**: Surface waters of the Gulf of Maine and Georges Bank as depicted in Figure 6.1. Generally, the following conditions exist where most American plaice eggs are found: sea surface temperatures below 12°C, water depths between 30 and 90 meters and a wide range of salinities. American plaice eggs are observed all year in the Gulf of Maine, but only from December through June on Georges Bank, with peaks in both areas in April and May.

**Larvae**: Surface waters of the Gulf of Maine, Georges Bank and southern New England as depicted in Figure 6.2. Generally, the following conditions exist where most American plaice larvae are found: sea surface temperatures below 14°C, water depths between 30 and 130 meters and a wide range of salinities. American plaice larvae are observed between January and August, with peaks in April and May.

**Juveniles**: Bottom habitats with fine-grained sediments or a substrate of sand or gravel in the Gulf of Maine as depicted in Figure 6.3. Generally, the following conditions exist where most American plaice juveniles are found: water temperatures below 17°C, depths between 45 and 150 meters and a wide range of salinities.

**Adults**: Bottom habitats with fine-grained sediments or a substrate of sand or gravel in the Gulf of Maine and Georges Bank as depicted in Figure 6.4. Generally, the following conditions exist where most American plaice adults are found: water temperatures below 17°C, depths between 45 and 175 meters and a wide range of salinities.

**Spawning Adults**: Bottom habitats of all substrate types in the Gulf of Maine and Georges Bank as depicted in Figure 6.4. Generally, the following conditions exist where most spawning American plaice adults are found: water temperatures below 14°C, depths less than 90 meters and a wide range of salinities. Spawning begins in March and continues through June.
All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
### EFH Designation of Estuaries and Embayments

**American plaice (Hippoglossoides platessoides)**

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M = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

F = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Figure 6.1: The EFH designation for American plaice eggs is based upon alternative 2 for American plaice eggs. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting American plaice eggs at the "common" or "abundant" level. This alternative was selected to represent those areas most important to American plaice spawning and egg survival, while not including those areas where American plaice eggs occurred in relatively low concentrations. The light shading represents the entire observed range of American plaice eggs.
Essential Fish Habitat
American plaice (*Hippoglossoides platessoides*) Larvae

Figure 6.2: The EFH designation for American plaice larvae is based upon alternative 2 for American plaice larvae. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting American plaice larvae at the "common" or "abundant" level. This alternative was selected to represent those areas most important to American plaice spawning and larval survival, while not including those areas where American plaice larvae occurred in relatively low concentrations. The light shading represents the entire observed range of American plaice larvae.
Essential Fish Habitat
American plaice (*Hippoglossoides platessoides*) Juveniles

Figure 6.3: The EFH designation for juvenile American plaice is based upon alternative 3 for American plaice juveniles. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for American plaice juveniles, as well as those bays and estuaries identified by the NOAA ELMR program as supporting American plaice juveniles at the "common" or "abundant" level. This designation was selected to include the areas where American plaice are most abundant, given that they are most concentrated in the Gulf of Maine and occur in relatively low concentrations on Georges Bank. The light shading represents the entire observed range of juvenile American plaice.
Figure 6.4: The EFH designation for adult American plaice is based upon alternative 3 for American plaice adults. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for American plaice adults, as well as those bays and estuaries identified by the NOAA ELMR program as supporting American plaice adults at the "common" or "abundant" level. This designation was selected to include the areas where American plaice are most abundant, given that they are most concentrated in the Gulf of Maine and occur in relatively low concentrations on Georges Bank. The light shading represents the entire observed range of adult American plaice.
Essential Fish Habitat Description

Pollock (*Pollachius virens*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined there is not enough information to determine if pollock is overfished or approaching an overfished condition. Essential Fish Habitat for pollock is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 7.1 - 7.4 and in the accompanying table and meet the following conditions:

**Eggs:** Pelagic waters of the Gulf of Maine and Georges Bank as depicted in Figure 7.1. Generally, the following conditions exist where pollock eggs are found: sea surface temperatures less than 17°C, water depths 30 and 270 meters, and salinities between 32 - 32.8‰. Pollock eggs are often observed from October through June with peaks from November to February.

**Larvae:** Pelagic waters of the Gulf of Maine and Georges Bank as depicted in Figure 7.2. Generally, the following conditions exist where pollock larvae are found: sea surface temperatures less than 17°C and water depths between 10 and 250 meters. Pollock larvae are often observed from September to July with peaks from December to February.

**Juveniles:** Bottom habitats with aquatic vegetation or a substrate of sand, mud or rocks in the Gulf of Maine and Georges Bank as depicted in Figure 7.3. Generally, the following conditions exist where pollock juveniles are found: water temperatures below 18°C, depths from 0 - 250 meters, and salinities between 29 - 32‰.

**Adults:** Bottom habitats in the Gulf of Maine and Georges Bank and hard bottom habitats (including artificial reefs) off southern New England and the middle Atlantic south to New Jersey as depicted in Figure 7.4. Generally, the following conditions exist where pollock adults are found: water temperatures below 14°C, depths from 15 - 365 meters, and salinities between 31 - 34‰.

**Spawning Adults:** Bottom habitats with a substrate of hard, stony or rocky bottom in the Gulf of Maine and hard bottom habitats (including artificial reefs) off southern New England and the middle Atlantic south to New Jersey as depicted in Figure 7.4. Generally, the following conditions exist where pollock adults are found: water temperatures below 8°C, depths from 15 - 365 meters, and salinities between 32 - 32.8‰. Pollock are most often observed spawning during the months September to April with peaks from December to February.
All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
### EFH Designation of Estuaries and Embayments

**Pollock (Pollachius virens)**

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**F** = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury *et al*. 1994; Stone *et al*. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Essential Fish Habitat
Pollock (*Pollachius virens*) Eggs

Figure 7.1: The EFH designation for pollock eggs is based upon alternative 3 for pollock adults. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting pollock eggs at the "common" or "abundant" level. The observed distribution of pollock eggs is very patchy and widely dispersed and does not match up with distributions of juveniles or adults, thus the distribution of adults was used as a proxy. This alternative was selected as it appears to best identify that portion of the range of pollock most important to all life history stages. The light shading represents the entire observed range of pollock eggs.
Essential Fish Habitat
Pollock (*Pollachius virens*) Larvae

Figure 7.2: The EFH designation for pollock larvae is based upon alternative 3 for pollock adults. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting pollock larvae at the "common" or "abundant" level. The observed distribution of pollock larvae is very patchy and widely dispersed and does not match up with distributions of juveniles or adults, thus the distribution of adults was used as a proxy. This alternative was selected as it appears to best identify that portion of the range of pollock most important to all life history stages. The light shading represents the entire observed range of pollock larvae.
Essential Fish Habitat
Pollock (*Pollachius virens*) Juveniles

Figure 7.3: The EFH designation for juvenile pollock is based upon alternative 3 for pollock adults. This alternative was selected as it appears to best identify that portion of the range of pollock most important to all life history stages. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for pollock, as well as those bays and estuaries identified by the NOAA ELMR program as supporting juvenile pollock at the "common" or "abundant" level. The light shading represents the entire observed range of juvenile pollock.

Essential Fish Habitat
Pollock (*Pollachius virens*) Adults
Figure 7.4: The EFH designation for adult pollock is based upon alternative 3 for pollock adults. This alternative was selected as it appears to best identify that portion of the range of pollock most important to all life history stages. The EFH designation also includes areas identified by the fishing industry and the inshore surveys as important for pollock, as well as those bays and estuaries identified by the NOAA ELMR program as supporting adult pollock at the "common" or "abundant" level. The light shading represents the entire observed range of adult pollock.
Essential Fish Habitat Description

Red hake (*Urophycis chuss*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined red hake is currently overfished. This determination is based on an assessment of stock size. Essential Fish Habitat for red hake is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 8.1 - 8.4 and in the accompanying table and meet the following conditions:

**Eggs:** Surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 8.1. Generally, the following conditions exist where hake eggs are found: sea surface temperatures below 10°C along the inner continental shelf with a salinity less than 25‰. Hake eggs are most often observed during the months from May - November, with peaks in June and July.

**Larvae:** Surface waters of Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 8.2. Generally, the following conditions exist where red hake larvae are found: sea surface temperatures below 19°C, water depths less than 200 meters, and a salinity greater than 0.5‰. Red hake larvae are most often observed from May through December, with peaks in September - October.

**Juveniles:** Bottom habitats with a substrate of shell fragments, including areas with an abundance of live scallops, in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 8.3. Generally, the following conditions exist where red hake juveniles are found: water temperatures below 16°C, depths less than 100 meters and a salinity range from 31 - 33‰.

**Adults:** Bottom habitats in depressions with a substrate of sand and mud in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 8.4. Generally, the following conditions exist where red hake adults are found: water temperatures below 12°C, depths from 10 - 130 meters, and a salinity range from 33 - 34‰.

**Spawning Adults:** Bottom habitats in depressions with a substrate of sand and mud in the Gulf of Maine, the southern edge of Georges Bank, the continental shelf off southern New England, and the middle Atlantic
south to Cape Hatteras as depicted in Figure 8.4. Generally, the following conditions exist where spawning red hake adults are found: water temperatures below 10°C, water depths less than 100 meters and salinity less than 25‰. Red hake are most often observed spawning during the months from May - November, with peaks in June and July.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
### EFH Designation of Estuaries and Embayments

**Red hake (Urophycis chuss)**

<table>
<thead>
<tr>
<th>Estuaries and Embayments</th>
<th>Eggs</th>
<th>Larvae</th>
<th>Juveniles</th>
<th>Adults</th>
<th>Spawning Adults</th>
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S = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

M = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

F = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Figure 8.1: The EFH designation for red hake eggs is based upon alternative 3 for red hake juveniles in combination with alternative 3 for hake (Urophycis spp.) eggs. The observed distribution of hake eggs was not unique to red hake and did not reflect the portion of the population in the Gulf of Maine, so the combination of juveniles and eggs was used as a proxy to identify those areas important to red hake eggs. These alternatives were selected to cover the areas most important to red hake development. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting red hake eggs at a "common" or "abundant" level. The light shading represents the entire observed range of hake eggs.
Essential Fish Habitat
Red hake (*Urophycis chuss*) Larvae

Figure 8.2: The EFH designation for red hake larvae is based upon alternative 3 for red hake juveniles in combination with alternative 3 for hake (*Urophycis* spp.) eggs. The observed distribution of red hake larvae was patchy and sparse, so the combination of juveniles and eggs was used as a proxy to identify those areas important to red hake larvae. These alternatives were selected to cover the areas most important to red hake development. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting red hake larvae at a "common" or "abundant" level. The light shading represents the entire observed range of hake larvae.
Essential Fish Habitat
Red hake (*Urophycis chuss*) Juveniles

Figure 8.3: The EFH designation for juvenile red hake is based upon alternative 3 for juvenile red hake. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting juvenile red hake at a "common" or "abundant" level. This alternative was selected to be inclusive of most areas where red hake occur in relatively high concentrations. The light shading represents the entire observed range of juvenile red hake.
Figure 8.4: The EFH designation for adult red hake is based upon alternative 3 for adult red hake. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting adult red hake at a "common" or "abundant" level. This alternative was selected to be inclusive of most areas where red hake occur in relatively high concentrations. The light shading represents the entire observed range of adult red hake.
Essential Fish Habitat Description

Redfish (*Sebastes* spp.)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined redfish is neither currently overfished nor approaching an overfished condition. This determination is based on the fishing mortality rate. The identification and description of EFH for redfish includes two species, *Sebastes faciatus* and *S. mentella*. Essential Fish Habitat for redfish is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 9.1 - 9.3 and meet the following conditions:

**Eggs:** Redfish are ovoviviparous. Redfish eggs are fertilized internally and develop into larvae within the oviduct. Therefore, there is no essential fish habitat identification or description for this life history stage.

**Larvae:** Pelagic waters in the Gulf of Maine and southern Georges Bank as depicted in Figure 9.1. Generally, the following conditions exist where redfish larvae are found: sea surface temperatures below 15°C and water depths between 50 and 270 meters. Redfish larvae are most often observed from March through October, with a peak in August.

**Juveniles:** Bottom habitats with a substrate of silt, mud or hard bottom in the Gulf of Maine and on the southern edge of Georges Bank as depicted in Figure 9.2. Generally, the following conditions exist where redfish juveniles are found: water temperatures below 13°C, depths from 25 - 400 meters, and a salinity range from 31 - 34‰.

**Adults:** Bottom habitats with a substrate of silt, mud or hard bottom in the Gulf of Maine and on the southern edge of Georges Bank as depicted in Figure 9.3. Generally, the following conditions exist where redfish adults are found: water temperatures below 13°C, depths from 50 - 350 meters, and a salinity range from 31 - 34‰.

**Spawning Adults:** Bottom habitats with a substrate of silt, mud or hard bottom in the Gulf of Maine and on the southern edge of Georges Bank as depicted in Figure 9.3. Generally, the following conditions exist where redfish adults are found: water temperatures below 13°C, depths from 50 - 350 meters, and a salinity range from 31 - 34‰. Redfish females are most often observed spawning (larvae) during the months from April through August.

The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
Essential Fish Habitat
Redfish (*Sebastes* spp.) Larvae

Figure 9.1: The EFH designation for redfish larvae is based upon alternative 4 for redfish adults. The larvae distribution was very patchy and does not point to areas of relatively high concentrations, so the adult distribution serves as a proxy to identify those areas where redfish larvae are most likely to be. This alternative was selected in order to include important areas in the historical range of redfish on the southeastern portion of Georges Bank, as well as to reflect that the entire Gulf of Maine is important redfish habitat. The light shading represents the entire observed range of redfish larvae.
Essential Fish Habitat
Redfish (*Sebastes* spp.) Juveniles

Figure 9.2: The EFH designation for juvenile redfish is based upon alternative 4 for redfish adults. This alternative was selected in order to include important areas in the historical range of redfish on the southeastern portion of Georges Bank, as well as to reflect that the entire Gulf of Maine is important redfish habitat. This species is very long lived and has tight habitat associations that are important to several life history stages, especially juveniles. The Council chose to be as conservative as possible in the EFH designation. The light shading represents the entire observed range of juvenile redfish.
Figure 9.3: The EFH designation for adult redfish is based upon alternative 4 for redfish adults. This alternative was selected in order to include important areas in the historical range of redfish on the southeastern portion of Georges Bank, as well as to reflect that the entire Gulf of Maine is important redfish habitat. This species is very long lived and has tight habitat associations that are important to several life history stages. The Council chose to be as conservative as possible in the EFH designation. The light shading represents the entire observed range of adult redfish.
Essential Fish Habitat Description

Atlantic salmon (*Salmo salar*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined Atlantic salmon is considered overfished, based upon an assessment of stock level. Essential fish habitat for Atlantic salmon is described as all waters currently or historically accessible to Atlantic salmon within the streams, rivers, lakes, ponds, wetlands, and other water bodies of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut identified as EFH in Figures 10.1 - 10.3 and in the accompanying table and that meet the following conditions:

**Eggs:** Bottom habitats with a gravel or cobble riffle (redd) above or below a pool of rivers as depicted in Figure 10.1. Generally, the following conditions exist in the egg pits (redds): water temperatures below 10° C, and clean, well-oxygenated fresh water. Atlantic salmon eggs are most frequently observed between October and April.

**Larvae:** Bottom habitats with a gravel or cobble riffle (redd) above or below a pool of rivers as depicted in Figure 10.1. Generally, the following conditions exist where Atlantic salmon larvae, or alevins/fry, are found: water temperatures below 10° C, and clean, well-oxygenated fresh water. Atlantic salmon alevins/fry are most frequently observed between March and June.

**Juveniles:** Bottom habitats of shallow gravel / cobble riffles interspersed with deeper riffles and pools in rivers and estuaries as depicted in Figure 10.2. Generally, the following conditions exist where Atlantic salmon parr are found: clean, well-oxygenated fresh water, water temperatures below 25° C, water depths between 10 cm and 61 cm, and water velocities between 30 and 92 cm per second. As they grow, parr transform into smolts. Atlantic salmon smolts require access downstream to make their way to the ocean. Upon entering the sea, "post-smolts" become pelagic and range from Long Island Sound north to the Labrador Sea.

**Adults:** For adult Atlantic salmon returning to spawn, habitats with resting and holding pools in rivers and estuaries as depicted in Figure 10.3. Returning Atlantic salmon require access to their natal streams and access to the spawning grounds. Generally, the following conditions exist where returning Atlantic salmon adults are found migrating to the spawning grounds: water temperatures below 22.8° C, and dissolved oxygen above 5 ppm. Oceanic adult Atlantic salmon are primarily pelagic and range from the waters of the continental shelf off southern New England north throughout the Gulf of Maine.
**Spawning Adults:** Bottom habitats with a gravel or cobble riffle (redd) above or below a pool of rivers as depicted in Figure 10.3. Generally, the following conditions exist where spawning Atlantic salmon adults are found: water temperatures below 10°C, water depths between 30 cm and 61 cm, water velocities around 61 cm per second, and clean, well-oxygenated fresh water. Spawning Atlantic salmon adults are most frequently observed during October and November.

Atlantic salmon EFH includes all aquatic habitats in the watersheds of the identified rivers, including all tributaries, to the extent that they are currently or were historically accessible for salmon migration. Atlantic salmon EFH excludes areas upstream of longstanding naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). All of the above EFH descriptions include those bays and estuaries listed on the following table.
### EFH Designation of Estuaries and Embayments

**Atlantic salmon (Salmo salar)**

<table>
<thead>
<tr>
<th>Estuaries and Embayments</th>
<th>Eggs</th>
<th>Larvae</th>
<th>Juveniles</th>
<th>Adults</th>
<th>Spawning Adults</th>
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S = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

M = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

F = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Essential Fish Habitat
Atlantic salmon (*Salmo salar*) Eggs and Larvae

Figure 10.1: The EFH designation for Atlantic salmon eggs and larvae represents all rivers where Atlantic salmon are currently present [26 rivers]. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting Atlantic salmon eggs and larvae at the "abundant", "common" or "rare" level. This alternative was selected to ensure that all rivers currently capable of supporting Atlantic salmon are included in the EFH designation. The guidance in the Interim Final Rule directs that for overfished species where habitat loss or degradation may be contributing to the overfished condition, all habitats currently used by the species should be considered essential. The rivers from which Atlantic salmon have been extirpated were not selected as EFH on the presumption that it would be extremely unlikely that these rivers will again support Atlantic salmon without artificial supplementation or stocking.
Figure 10.2: The EFH designation for Atlantic salmon juveniles represents all rivers where Atlantic salmon are currently present [26 rivers]. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting Atlantic salmon juveniles at the "abundant", "common" or "rare" level. This alternative was selected to ensure that all rivers currently capable of supporting Atlantic salmon are included in the EFH designation. The guidance in the Interim Final Rule directs that for overfished species where habitat loss or degradation may be contributing to the overfished condition, all habitats currently used by the species should be considered essential. The rivers from which Atlantic salmon have been extirpated were not selected as EFH on the presumption that it would be extremely unlikely that these rivers will again support Atlantic salmon without artificial supplementation or stocking.
Figure 10.3: The EFH designation for Atlantic salmon adults represents all rivers where Atlantic salmon are currently present [26 rivers]. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting Atlantic salmon adults at the "abundant", "common" or "rare" level. This alternative was selected to ensure that all rivers currently capable of supporting Atlantic salmon are included in the EFH designation. The guidance in the Interim Final Rule directs that for overfished species where habitat loss or degradation may be contributing to the overfished condition, all habitats currently used by the species should be considered essential. The rivers from which Atlantic salmon have been extirpated were not selected as EFH on the presumption that it would be extremely unlikely that these rivers will again support Atlantic salmon without artificial supplementation or stocking.
Essential Fish Habitat Description

Atlantic sea scallops (*Placopecten magellanicus*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined Atlantic sea scallops are currently overfished. This determination is based on the fishing mortality rate. Essential fish habitat for Atlantic sea scallops is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figure 11.1 and in the accompanying table and meet the following conditions:

**Eggs:** Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border as depicted in Figure 11.1. Eggs are heavier than seawater and remain on the seafloor until they develop into the first free-swimming larval stage. Generally, sea scallop eggs are thought to occur where water temperatures are below 17° C. Spawning occurs from May through October, with peaks in May and June in the middle Atlantic area and in September and October on Georges Bank and in the Gulf of Maine.

**Larvae:** Pelagic waters and bottom habitats with a substrate of gravelly sand, shell fragments, and pebbles, or on various red algae, hydroids, amphipod tubes and bryozoans in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border as depicted in Figure 11.1. Generally, the following conditions exist where sea scallop larvae are found: sea surface temperatures below 18° C and salinities between 16.9‰ and 30‰.

**Juveniles:** Bottom habitats with a substrate of cobble, shells and silt in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border that support the highest densities of sea scallops as depicted in Figure 11.1. Generally, the following conditions exist where most sea scallop juveniles are found: water temperatures below 15° C, and water depths from 18 - 110 meters.

**Adults:** Bottom habitats with a substrate of cobble, shells, coarse/gravelly sand, and sand in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border that support the highest densities of sea scallops as depicted in Figure 11.1. Generally, the following conditions exist where most sea scallop adults are found: water temperatures below 21° C, water depths from 18 - 110 meters, and salinities above 16.5‰.

**Spawning Adults:** Bottom habitats with a substrate of cobble, shells, coarse/gravelly sand, and sand in the Gulf of Maine, Georges Bank,
southern New England and the middle Atlantic south to the Virginia-North Carolina border that support the highest densities of sea scallops as depicted in Figure 11.1. Generally, the following conditions exist where spawning sea scallop adults are found: water temperatures below 16°C, depths from 18 - 110 meters, and salinities above 16.5‰. Spawning occurs from May through October, with peaks in May and June in the middle Atlantic area and in September and October on Georges Bank and in the Gulf of Maine.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
**EFH Designation of Estuaries and Embayments**  
*Atlantic sea scallops (Placopecten magellanicus)*

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<th>Estuaries and Embayments</th>
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S = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

M = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

F = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Essential Fish Habitat
Atlantic sea scallops (*Placopecten magellanicus*) All Life Stages

Figure 11.1: The EFH designation for Atlantic sea scallops is based upon alternative 2, based on the NMFS scallop survey (1982 - 1997), plus areas identified by the fishing industry and by NMFS as important for sea scallops. The designation also includes the mid-Atlantic juvenile sea scallop closed areas (the Hudson Canyon Closed Area and the Virginia Beach Closed Area) and those bays and estuaries identified by the NOAA ELMR program as supporting sea scallops at the "common" or "abundant" level. The other alternatives were not selected because they either include too little area (less than half of the range of this overfished species), or include areas where sea scallops occur in relatively low concentrations. The light shading represents the entire observed range of Atlantic sea scallops.
Essential Fish Habitat Description

White hake (*Urophycis tenuis*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined white hake is not currently overfished, but it is approaching an overfished condition. This determination is based on an assessment of stock level. Essential Fish Habitat for white hake is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 12.1 - 12.4 and in the accompanying table and meet the following conditions:

**Eggs:** Surface waters of the Gulf of Maine, Georges Bank, and southern New England as depicted in Figure 12.1. White hake eggs are most often observed in August and September.

**Larvae:** Pelagic waters of the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic as depicted in Figure 12.2. White hake larvae are most often observed in May in the mid-Atlantic area and August and September in the Gulf of Maine and Georges Bank.

**Juveniles:** *Pelagic stage* -- Pelagic waters of the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic as depicted in Figure 12.3. White hake juveniles in the pelagic stage are most often observed from May through September. *Demersal stage* -- Bottom habitats with seagrass beds or a substrate of mud or fine-grained sand in the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic as depicted in Figure 12.3. Generally, the following conditions exist where white hake juveniles are found: water temperatures below 19° C and depths from 5 - 225 meters.

**Adults:** Bottom habitats with a substrate of mud or fine-grained sand in the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic as depicted in Figure 12.4. Generally, the following conditions exist where white hake adults are found: water temperatures below 14° C and depths from 5 - 325 meters.

**Spawning Adults:** Bottom habitats with a substrate of mud or fine-grained sand in deep water in the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic as depicted in Figure 12.4. Generally, the following conditions exist where white hake adults are found: water temperatures below 14° C and depths from 5 - 325 meters. White hake are most often observed spawning...
during the months April - May in the southern portion of their range and August - September in the northern portion of their range.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
**EFH Designation of Estuaries and Embayments**  
White hake (*Urophycis tenuis*)

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<th>Estuaries and Embayments</th>
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S = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

M = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

F = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury *et al.* 1994; Stone *et al.* 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Figure 12.1: The EFH designation for white hake eggs is based upon alternative 3 for white hake adults. There are no data on white hake eggs, so the use of the adult distribution serves as a proxy to identify those areas where white hake eggs are most likely to be. Alternative 3 for adults includes all areas thought to be most important for eggs, including southern Georges Bank. The EFH designation includes those bays and estuaries identified by the NOAA ELMR program as supporting white hake eggs at the "common" or "abundant" level. The other alternatives were not selected because they either include too little area (not incorporating southern Georges Bank), or include areas where white hake occur in relatively low concentrations (throughout southern New England and the middle Atlantic). The light shading represents the entire observed range of adult white hake.
Essential Fish Habitat
White hake (*Urophycis tenuis*) Larvae

Figure 12.2: The EFH designation for white hake larvae is based upon alternative 3 for white hake adults. There are no data on white hake larvae, so the use of the adult distribution serves as a proxy to identify those areas where white hake larvae are most likely to be. Alternative 3 for adults includes all areas thought to be most important for larvae, including southern Georges Bank. The EFH designation includes those bays and estuaries identified by the NOAA ELMR program as supporting white hake larvae at the "common" or "abundant" level. The other alternatives were not selected because they either include too little area (not incorporating southern Georges Bank), or include areas where white hake occur in relatively low concentrations (throughout southern New England and the middle Atlantic). The light shading represents the entire observed range of adult white hake.
Figure 12.3: The EFH designation for juvenile white hake is based upon alternative 3 for white hake adults. Alternative 3 for adults includes all areas thought to be most important for juveniles, including southern Georges Bank. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for white hake, as well as those bays and estuaries identified by the NOAA ELMR program as supporting juvenile white hake at the "common" or "abundant" level. The other alternatives were not selected because they either include too little area (not incorporating southern Georges Bank), or include areas where white hake occur in relatively low concentrations (throughout southern New England and the middle Atlantic). The light shading represents the entire observed range of juvenile white hake.
Essential Fish Habitat
White hake (*Urophycis tenuis*) Adults

Figure 12.4: The EFH designation for adult white hake is based upon alternative 3 for white hake adults. Alternative 3 includes all areas thought to be most important to white hake, including southern Georges Bank. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for white hake, as well as those bays and estuaries identified by the NOAA ELMR program as supporting white hake at the "common" or "abundant" level. The other alternatives were not selected because they either include too little area (not incorporating southern Georges Bank), or include areas where white hake occur in relatively low concentrations (throughout southern New England and the middle Atlantic). The light shading represents the entire observed range of adult white hake.
Essential Fish Habitat Description

Whiting (Merluccius bilinearis)

In its Report to Congress: Status of the Fisheries of the United States (September 1997), NMFS determined the Southern Georges Bank / Middle Atlantic stock of whiting is considered overfished, based on an assessment of the stock level. The Gulf of Maine / Northern Georges Bank stock of whiting is not considered currently overfished but it is considered to be approaching an overfished condition, also based on the stock level associated with this stock. Essential Fish Habitat for whiting is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 13.1 - 13.4 and in the accompanying table and meet the following conditions:

**Eggs:** Surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 13.1. Generally, the following conditions exist where most whiting eggs are found: sea surface temperatures below 20° C and water depths between 50 and 150 meters. Whiting eggs are observed all year, with peaks from June through October.

**Larvae:** Surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 13.2. Generally, the following conditions exist where most whiting larvae are found: sea surface temperatures below 20° C and water depths between 50 and 130 meters. Whiting larvae are observed all year, with peaks from July through September.

**Juveniles:** Bottom habitats of all substrate types in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 13.3. Generally, the following conditions exist where most whiting juveniles are found: water temperatures below 21° C, depths between 20 and 270 meters and salinities greater than 20‰.

**Adults:** Bottom habitats of all substrate types in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 13.4. Generally, the following conditions exist where most whiting adults are found: water temperatures below 22° C and depths between 30 and 325 meters.

**Spawning Adults:** Bottom habitats of all substrate types in the Gulf of
Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 13.4. Generally, the following conditions exist where most spawning whiting adults are found: water temperatures below 13°C and depths between 30 and 325 meters.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
### EFH Designation of Estuaries and Embayments
**Whiting (Merluccius bilinearis)**

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<th>Estuaries and Embayments</th>
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S = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

M = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

F = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Essential Fish Habitat
Whiting (*Merluccius bilinearis*) Eggs

Figure 13.1: The EFH designation for whiting eggs is based upon alternative 3 for whiting juveniles. Whiting spawn in the summer months in the Gulf of Maine, but there has been very limited MARMAP sampling during this period. This is thought to explain why there have been few eggs observed in the Gulf of Maine despite the high concentrations of juveniles and adults. The use of the juvenile distribution serves as a proxy to identify those areas where whiting eggs are most likely to be. The EFH designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting whiting eggs at the "common" or "abundant" level. The light shading represents the entire observed range of whiting eggs.
Figure 13.2: The EFH designation for whiting larvae is based upon alternative 3 for whiting juveniles. Whiting spawn in the summer months in the Gulf of Maine, but there has been very limited MARMAP sampling during this period. This is thought to explain why there have been very few larvae observed in the Gulf of Maine despite the high concentrations of juveniles and adults. The use of the juvenile distribution serves as a proxy to identify those areas where whiting larvae are most likely to be. The EFH designations also include those bays and estuaries identified by the NOAA ELMR program as supporting whiting larvae at the "common" or "abundant" level. The light shading represents the entire observed range of whiting larvae.
Figure 13.3: The EFH designation for juvenile whiting is based upon alternative 3 for whiting juveniles. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for whiting, as well as those bays and estuaries identified by the NOAA ELMR program as supporting juvenile whiting at the "common" or "abundant" level. The other alternatives were not selected because they either include too little area (less than half of the range of this overfished species), or include areas where whiting occur in relatively low concentrations. The light shading represents the entire observed range of juvenile whiting.
Figure 13.4: The EFH designation for adult whiting is based upon alternative 3 for whiting adults. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for whiting, as well as those bays and estuaries identified by the NOAA ELMR program as supporting adult whiting at the "common" or "abundant" level. The other alternatives were not selected because they either include too little area (less than half of the range of this overfished species), or include areas where whiting occur in relatively low concentrations. The light shading represents the entire observed range of adult whiting.
Essential Fish Habitat Description
Windowpane flounder (*Scophthalmus aquosus*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined windowpane flounder is currently overfished. This determination is based on an assessment of stock level. Essential Fish Habitat for windowpane flounder is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 14.1 - 14.4 and in the accompanying table and meet the following conditions:

**Eggs:** Surface waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 14.1. Generally, the following conditions exist where windowpane flounder eggs are found: sea surface temperatures less than 20° C and water depths less than 70 meters. Windowpane flounder eggs are often observed from February to November with peaks in May and October in the middle Atlantic and July - August on Georges Bank.

**Larvae:** Pelagic waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 14.2. Generally, the following conditions exist where windowpane flounder larvae are found: sea surface temperatures less than 20° C and water depths less than 70 meters. Windowpane flounder larvae are often observed from February to November with peaks in May and October in the middle Atlantic and July through August on Georges Bank.

**Juveniles:** Bottom habitats with a substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras as depicted in Figure 14.3. Generally, the following conditions exist where windowpane flounder juveniles are found: water temperatures below 25° C, depths from 1 - 100 meters, and salinities between 5.5 - 36‰.

**Adults:** Bottom habitats with a substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border as depicted in Figure 14.4. Generally, the following conditions exist where windowpane flounder adults are found: water temperatures below 26.8° C, depths from 1 - 75 meters, and salinities between 5.5 - 36‰.

**Spawning Adults:** Bottom habitats with a substrate of mud or fine-
grained sand in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border as depicted in Figure 14.4. Generally, the following conditions exist where windowpane flounder adults are found: water temperatures below 21° C, depths from 1 - 75 meters, and salinities between 5.5 - 36‰. Windowpane flounder are most often observed spawning during the months February - December with a peak in May in the middle Atlantic.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
EFH Designation of Estuaries and Embayments

Windowpane flounder (*Scophthalmus aquosus*)

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<th>Estuaries and Embayments</th>
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These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living...
Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Figure 14.1: The EFH designation for windowpane flounder eggs is based upon alternative 3 for windowpane flounder eggs. The EFH designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting windowpane flounder eggs at the "common" or "abundant" level. This alternative was selected to be as inclusive as possible, given the generally patchy nature of egg distribution, while not including areas with relatively very low concentrations of windowpane flounder eggs. The light shading represents the entire observed range of windowpane flounder eggs.
Figure 14.2: The EFH designation for windowpane flounder larvae is based upon alternative 3 for windowpane flounder larvae. The EFH designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting windowpane flounder larvae at the "common" or "abundant" level. This alternative was selected to be as inclusive as possible, given the generally patchy nature of larval distribution, while not including areas with relatively very low concentrations of windowpane flounder larvae. The light shading represents the entire observed range of windowpane flounder larvae.
Figure 14.3: The EFH designation for juvenile windowpane flounder is based upon alternative 3 for windowpane flounder juveniles. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for windowpane flounder, as well as those bays and estuaries identified by the NOAA ELMR program as supporting juvenile windowpane flounder at the "common" or "abundant" level. The other alternatives were not selected because they either include too little area (less than half of the range of this overfished species), or include areas where windowpane flounder occur in relatively low concentrations. The light shading represents the entire observed range of juvenile windowpane flounder.
Essential Fish Habitat
Windowpane flounder (*Scophthalmus aquosus*) Adults

Figure 14.4: The EFH designation for adult windowpane flounder is based upon alternative 3 for windowpane flounder adults. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for windowpane flounder, as well as those bays and estuaries identified by the NOAA ELMR program as supporting adult windowpane flounder at the "common" or "abundant" level. The other alternatives were not selected because they either include too little area (less than half of the range of this overfished species), or include areas where windowpane flounder occur in relatively low concentrations. The light shading represents the entire observed range of adult windowpane flounder.
Essential Fish Habitat Description

Winter flounder (Pleuronectes americanus)

In its Report to Congress: Status of the Fisheries of the United States (September 1997), NMFS determined the Gulf of Maine and Southern New England stocks of winter flounder are currently overfished. This determination is based on the fishing mortality rate. There is not enough information to determine if the Georges Bank stock is overfished or approaching an overfished condition. Essential Fish Habitat for winter flounder is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 15.1 - 15.4 and in the accompanying table and meet the following conditions:

**Eggs:** Bottom habitats with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay as depicted in Figure 15.1. Generally, the following conditions exist where winter flounder eggs are found: water temperatures less than 10°C, salinities between 10 - 30‰, and water depths less than 5 meters. On Georges Bank, winter flounder eggs are generally found in water less than 8°C and less than 90 meters deep. Winter flounder eggs are often observed from February to June with a peak in April on Georges Bank.

**Larvae:** Pelagic and bottom waters of Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay as depicted in Figure 15.2. Generally, the following conditions exist where winter flounder larvae are found: sea surface temperatures less than 15°C, salinities between 4 - 30‰, and water depths less than 6 meters. On Georges Bank, winter flounder larvae are generally found in water less than 8°C and less than 90 meters deep. Winter flounder larvae are often observed from March to July with peaks in April and May on Georges Bank.

**Juveniles:** Young-of-the-Year: Bottom habitats with a substrate of mud or fine grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay as depicted in Figure 15.3. Generally, the following conditions exist where winter flounder young-of-the-year are found: water temperatures below 28°C, depths from 0.1 - 10 meters, and salinities between 5 - 33‰. Age 1+ Juveniles: Bottom habitats with a substrate of mud or fine grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay as depicted in Figure 15.3. Generally, the following conditions exist where juvenile winter flounder are found: water temperatures below 25°C, depths from 1 - 50 meters, and salinities between 10 - 30‰.

**Adults:** Bottom habitats including estuaries with a substrate of mud, sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay as depicted in Figure 15.4. Generally, the following conditions exist where winter flounder adults are found: water temperatures below 25°C, depths from 1 - 100 meters, and salinities between 15 - 33‰.
**Spawning Adults:** Bottom habitats including estuaries with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay as depicted in Figure 15.4. Generally, the following conditions exist where winter flounder adults are found: water temperatures below 15° C, depths less than 6 meters, except on Georges Bank where they spawn as deep as 80 meters, and salinities between 5.5 - 36‰. Winter flounder are most often observed spawning during the months February - June.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
## EFH Designation of Estuaries and Embayments

**Winter flounder** (*Pleuronectes americanus*)

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<th>Estuaries and Embayments</th>
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**S** = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

**M** = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

**F** = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Resources Program.
Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Essential Fish Habitat
Winter flounder (*Pleuronectes americanus*) Eggs

Figure 15.1: The EFH designation for winter flounder eggs is based upon alternative 3 for winter flounder adults. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting winter flounder eggs at the "common" or "abundant" level. The observed distribution of winter flounder eggs is very patchy with very few observations, thus the distribution of adults was used as a proxy. This alternative was selected as it appears to best identify that portion of the range of winter flounder most important to all life history stages. The light shading represents the entire observed range of winter flounder eggs.
Figure 15.2: The EFH designation for winter flounder larvae is based upon alternative 3 for winter flounder adults. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting winter flounder larvae at the "common" or "abundant" level. The observed distribution of winter flounder larvae is very patchy with very few observations, thus the distribution of adults was used as a proxy. This alternative was selected as it appears to best identify that portion of the range of winter flounder most important to all life history stages. The light shading represents the entire observed range of winter flounder larvae.
Figure 15.3: The EFH designation for winter flounder juveniles is based upon alternative 3 for winter flounder adults. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for winter flounder, as well as those bays and estuaries identified by the NOAA ELMR program as supporting winter flounder juveniles at the "common" or "abundant" level. This alternative was selected as it appears to best identify that portion of the range of winter flounder most important to all life history stages. The other alternatives were not selected because they either include too little area (less than half of the range of this overfished species), or include areas where winter flounder occur in relatively low concentrations. The light shading represents the entire observed range of winter flounder juveniles.
Figure 15.4: The EFH designation for winter flounder adults is based upon alternative 3 for winter flounder adults. The EFH designations also include the areas identified by the fishing industry and the inshore surveys as important for winter flounder, as well as those bays and estuaries identified by the NOAA ELMR program as supporting winter flounder adults at the "common" or "abundant" level. This alternative was selected as it appears to best identify that portion of the range of winter flounder most important to all life history stages. The other alternatives were not selected because they either include too little area (less than half of the range of this overfished species), or include areas where winter flounder occur in relatively low concentrations. The light shading represents the entire observed range of winter flounder adults.
Essential Fish Habitat Description

Witch flounder (Glyptocephalus cynoglossus)

In its Report to Congress: Status of the Fisheries of the United States (September 1997), NMFS determined witch flounder is currently overfished. This determination is based on the fishing mortality rate. Essential Fish Habitat for witch flounder is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 16.1 - 16.4 and meet the following conditions:

**Eggs:** Surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 16.1. Generally, the following conditions exist where witch flounder eggs are found: sea surface temperatures below 13\(^\circ\)C over deep water with high salinities. Witch flounder eggs are most often observed during the months from March through October.

**Larvae:** Surface waters to 250 meters in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras as depicted in Figure 16.2. Generally, the following conditions exist where witch flounder larvae are found: sea surface temperatures below 13\(^\circ\)C over deep water with high salinities. Witch flounder larvae are most often observed from March through November, with peaks in May - July.

**Juveniles:** Bottom habitats with a fine-grained substrate in the Gulf of Maine and along the outer continental shelf from Georges Bank south to Cape Hatteras as depicted in Figure 16.3. Generally, the following conditions exist where witch flounder juveniles are found: water temperatures below 13\(^\circ\)C, depths from 50 - 450 meters, although they have been observed as deep as 1500 meters, and a salinity range from 34 - 36‰.

**Adults:** Bottom habitats with a fine-grained substrate in the Gulf of Maine and along the outer continental shelf from Georges Bank south to Chesapeake Bay as depicted in Figure 16.4. Generally, the following conditions exist where witch flounder adults are found: water temperatures below 13\(^\circ\)C, depths from 25 - 300 meters, and a salinity range from 32 - 36‰.

**Spawning Adults:** Bottom habitats with a fine-grained substrate in the Gulf of Maine and along the outer continental shelf from Georges Bank south to Chesapeake Bay as depicted in Figure 16.4. Generally, the following conditions exist where spawning witch flounder adults are
found: water temperatures below 15° C, depths from 25 - 360 meters, and a salinity range from 32 - 36‰. Witch flounder are most often observed spawning during the months from March through November, with peaks in May - August.

The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
Figure 16.1: The EFH designation for witch flounder eggs is based upon alternative 4 for witch flounder eggs. This alternative was selected to be as inclusive as possible of areas likely to support witch flounder eggs. The light shading represents the entire observed range of witch flounder eggs.
Figure 16.2: The EFH designation for witch flounder larvae is based upon alternative 4 for witch flounder larvae. This alternative was selected to be as inclusive as possible of areas likely to support witch flounder larvae. The light shading represents the entire observed range of witch flounder larvae.
Essential Fish Habitat
Witch flounder (*Glyptocephalus cynoglossus*) Juveniles

Figure 16.3: The EFH designation for juvenile witch flounder is based upon alternative 3 for witch flounder juveniles. This alternative was selected to include all areas where witch flounder occur in relatively high concentrations, but not areas where they occur in relatively low concentrations. The light shading represents the entire observed range of juvenile witch flounder.
Essential Fish Habitat
Witch flounder (*Glyptocephalus cynoglossus*) Adults

Figure 16.4: The EFH designation for adult witch flounder is based upon alternative 3 for witch flounder adults. This alternative was selected to include all areas where witch flounder occur in relatively high concentrations, but not areas where they occur in relatively low concentrations. The light shading represents the entire observed range of adult witch flounder.
Essential Fish Habitat Description

Yellowtail flounder (*Pleuronectes ferruginea*)

In its *Report to Congress: Status of the Fisheries of the United States* (September 1997), NMFS determined the Georges Bank and Southern New England stocks of yellowtail flounder are neither currently overfished nor approaching an overfished condition. There is not enough information to determine if the Cape Cod or Middle Atlantic stocks are overfished or approaching an overfished condition. For all four stocks of yellowtail flounder, essential fish habitat is described as those areas of the coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figures 17.1 - 17.4 and in the accompanying table and meet the following conditions:

**Eggs:** Surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, and the southern New England continental shelf south to Delaware Bay as depicted in Figure 17.1. Generally, the following conditions exist where yellowtail eggs are found: sea surface temperatures below 15°C, water depths from 30 - 90 meters and a salinity range from 32.4 - 33.5‰. Yellowtail flounder eggs are most often observed during the months from mid-March to July, with peaks in April to June in southern New England.

**Larvae:** Surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, the southern New England shelf and throughout the middle Atlantic south to the Chesapeake Bay as depicted in Figure 17.2. Generally, the following conditions exist where yellowtail larvae are found: sea surface temperatures below 17°C, water depths from 10 - 90 meters, and a salinity range from 32.4 - 33.5‰. Yellowtail flounder larvae are most often observed from March through April in the New York bight and from May through July in southern New England and southeastern Georges Bank.

**Juveniles:** Bottom habitats with a substrate of sand or sand and mud on Georges Bank, the Gulf of Maine, and the southern New England shelf south to Delaware Bay as depicted in Figure 17.3. Generally, the following conditions exist where yellowtail flounder juveniles are found: water temperatures below 15°C, depths from 20 - 50 meters and a salinity range from 32.4 - 33.5‰.

**Adults:** Bottom habitats with a substrate of sand or sand and mud on Georges Bank, the Gulf of Maine, and the southern New England shelf south to Delaware Bay as depicted in Figure 17.4. Generally, the following conditions exist where yellowtail flounder adults are found: water temperatures below 15°C, depths from 20 - 50 meters, and a salinity range from 32.4 - 33.5‰.
**Spawning Adults:** Bottom habitats with a substrate of sand or sand and mud on Georges Bank, the Gulf of Maine, and the southern New England shelf south to Delaware Bay as depicted in Figure 17.4. Generally, the following conditions exist where spawning yellowtail flounder adults are found: water temperatures below 17°C, depths from 10 - 125 meters, and a salinity range from 32.4 - 33.5‰.

All of the above EFH descriptions include those bays and estuaries listed on the following table, according to life history stage. The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
## EFH Designation of Estuaries and Embayments

**Yellowtail flounder (Pleuronectes ferruginea)**

<table>
<thead>
<tr>
<th>Estuaries and Embayments</th>
<th>Eggs</th>
<th>Larvae</th>
<th>Juveniles</th>
<th>Adults</th>
<th>Spawning Adults</th>
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<tbody>
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<td>Passamaquoddy Bay</td>
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<td>Englishman/Machias Bay</td>
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**S** = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

**M** = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

**F** = The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury *et al.* 1994; Stone *et al.* 1994). For a detailed view of the salinity zone boundaries, as described in the ELMR reports, please see Appendix B. The Council recognizes the spatial and temporal variability of estuarine and embayment environmental conditions generally associated with this species.
Figure 17.1: The EFH designation for yellowtail flounder eggs is based upon alternative 4 for yellowtail flounder eggs. In addition, this designation includes those bays and estuaries identified in the NOAA ELMR program as supporting yellowtail flounder eggs at the "rare", "common", or "abundant" level. This alternative was selected to be as inclusive as possible of areas likely to support yellowtail flounder eggs. The light shading represents the entire observed range of yellowtail flounder eggs.
Figure 17.2: The EFH designation for yellowtail flounder larvae is based upon alternative 4 for yellowtail flounder larvae. In addition, this designation includes those bays and estuaries identified in the NOAA ELMR program as supporting yellowtail flounder larvae at the "rare", "common", or "abundant" level. This alternative was selected to be as inclusive as possible of areas likely to support yellowtail flounder larvae. The light shading represents the entire observed range of yellowtail flounder larvae.
Figure 17.3: The EFH designation for juvenile yellowtail flounder is based upon alternative 3 for yellowtail flounder juveniles. In addition, this designation includes those bays and estuaries identified in the NOAA ELMR program as supporting yellowtail flounder juveniles at the "common" or "abundant" level. This alternative was selected because it included all areas where yellowtail flounder juveniles were observed in relatively high concentrations, but did not include areas where they occurred in low concentrations. The light shading represents the entire observed range of juvenile yellowtail flounder.
Figure 17.4: The EFH designation for adult yellowtail flounder is based upon alternative 3 for yellowtail flounder adults. In addition, this designation includes those bays and estuaries identified in the NOAA ELMR program as supporting yellowtail flounder adults at the "common" or "abundant" level, as well as areas identified by the fishing industry as important for spawning adults. This alternative was selected because it included all areas where yellowtail flounder adults were observed in relatively high concentrations, but did not include areas where they occurred in low concentrations. The light shading represents the entire observed range of adult yellowtail flounder.
**Essential Fish Habitat Description**

*Atlantic halibut (Hippoglossus hippoglossus)*

According to the NMFS' *Report to Congress: Status of the Fisheries of the United States* (September 1997), Atlantic halibut is currently overfished. This determination is based on an assessment of stock level. Essential Fish Habitat for Atlantic halibut is described as the area of the coastal and offshore waters (out to the offshore U.S. boundary of the Exclusive Economic Zone) that is designated on Figure 18.1 and meets the following conditions:

**Eggs:** Pelagic waters to the sea floor of the Gulf of Maine and Georges Bank as depicted in Figure 18.1. Generally, the following conditions exist where Atlantic halibut eggs are found: water temperatures between 4 and 7°C, water depths less than 700 meters, and salinities less than 35‰. Atlantic halibut eggs are observed between late fall and early spring, with peaks in November and December.

**Larvae:** Surface waters of the Gulf of Maine and Georges Bank as depicted in Figure 18.1. Generally, the following conditions exist where Atlantic halibut larvae are found: salinities between 30 and 35‰.

**Juveniles:** Bottom habitats with a substrate of sand, gravel, or clay in the Gulf of Maine and Georges Bank as depicted in Figure 18.1. Generally, the following conditions exist where Atlantic halibut juveniles are found: water temperatures above 2°C and depths from 20 - 60 meters.

**Adults:** Bottom habitats with a substrate of sand, gravel, or clay in the Gulf of Maine and Georges Bank as depicted in Figure 18.1. Generally, the following conditions exist where Atlantic halibut adults are found: water temperatures below 13.6°C, depths from 100 - 700 meters, and salinities between 30.4 - 35.3‰.

**Spawning Adults:** Bottom habitats with a substrate of soft mud, clay, sand, or gravel in the Gulf of Maine and Georges Bank, as well as rough or rocky bottom locations along the slopes of the outer banks, as depicted in Figure 18.1. Generally, the following conditions exist where spawning Atlantic halibut are found: water temperatures below 7°C, depths less than 700 meters, and salinities less than 35‰. Atlantic halibut are most often observed spawning between late fall and early spring, with peaks in November and December.

The Council acknowledges potential seasonal and spatial variability of the conditions generally associated with this species.
Essential Fish Habitat
Atlantic halibut (Hippoglossus hippoglossus) All life stages

Figure 18.1: The EFH designation for all life history stages of Atlantic halibut is based on the portion of the historic range of Atlantic halibut that coincides with entire observed range of Atlantic halibut (alternative 4). The historic range is based on a composite of areas known to support Atlantic halibut, described by: (1) Bigelow and Schroeder, 1953; (2) Goode and Collins, 1887; (3) Rich, 1929; and, (4) EFH Source Document, 1998. In the absence of other information, this portion of the historic range most accurately represents the areas used by and important to this species, where halibut are likely to be caught in the foreseeable future. The light shading represents the entire reported historic range of Atlantic halibut.
4.0 FISHING-RELATED IMPACTS AND MANAGEMENT MEASURES

4.1 BACKGROUND

The Council is required to identify and assess fishing activities that may adversely affect EFH. The Magnuson-Stevens Act defines fishing as "any activity, other than scientific research conducted by a scientific research vessel, that involves (1) the catching, taking, or harvesting of fish; (2) the attempted catching, taking, or harvesting of fish; (3) any other activity that can reasonably be expected to result in the catching, taking, or harvesting of fish; or (4) any operations at sea in support of, or in preparation for, any activity described in paragraphs (1), (2), or (3) of this definition" (50 CFR 600.10). Adverse effects from fishing may include physical, chemical, or biological alterations of the substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem.

The effects of fishing, such as the direct effects of gear on seafloor habitats (e.g., direct removal of epifauna, smoothed bedforms) and the indirect effects of fishing (e.g., producing shifts in the benthic community because of initial removals of fauna), and other habitat related fishing activities that can be controlled by the Council are considered in this assessment. NMFS recommends that the assessment include, if known: a description of the mechanisms or processes of fishing gear causing adverse effects on habitat; the particular portion of EFH that is affected; a description of known or potential habitat functions disturbed or disrupted by these effects and the extent of such disturbance or disruption; options the Council will consider to minimize adverse effects from fishing practices; and mitigation measures to conserve and enhance EFH adversely affected by fishing activities, if appropriate. According to NMFS, a gear assessment should consider the relative impact of the gear and rate gear types according to their relative impact on different types of EFH, and the Council should consider the severity of the effect, the amount of EFH affected, and the duration/lasting impact of the adverse effect. NMFS suggests the Council also take into account the sensitivity, rarity, resistance, and resilience of different habitat types.

4.2 GEAR IMPACTS ISSUES

The disturbance and alteration of natural seafloor and pelagic communities, even at small scales, is inevitable when fishing with any gear type. There is always a noticeable effect, since simply removing an organism has an effect at some level. This alteration is a necessary component of fishing, and in some cases the effect is relatively short-lived and minor (Jones 1992; Brylinsky et al. 1994). Considerations of anthropogenic impacts to habitat must include a comparison to chronic natural disturbances (e.g., currents, waves, etc.) as well as acute natural disturbances (e.g., storms). Wave-induced physical disturbances are rare, however, at depths greater than 30 meters, in large part because of the near-exponential decrease in wave-induced water velocity as a function of depth (Witman 1998; Valentine, pers.comm. 1998). Some types of fishing activities, especially in certain habitat types, may cause long-term changes in the habitat and the structure of the marine community (Auster et al. 1996; Kaiser and Spencer 1996). Auster and Langton (MS1998 and in press) produced a review and synthesis of the fishing gear...
impact literature for use by the Regional Fishery Management Councils. Ninety studies, virtually all focused on the seafloor, were reviewed. The studies all reported the effects of fishing on habitat (i.e., structural habitat components, community structure and ecosystem processes) for a diversity of habitats and fishing gear types. Immediate effects on species composition and diversity and a reduction in habitat complexity were documented in all the reviewed studies. Studies of acute effects were found to be a good predictor of chronic effects. Recovery after fishing was variable, depending on habitat type, life history strategy of component species, and the level of natural disturbance.

The spatial and temporal scales of fishing gear impact research do not generally correspond to the spatial and temporal patterns of fishing activities and ecosystem functions. The challenge is to apply the results of relatively small-scale gear and habitat specific studies as well as the results of long-term chronic impact studies (which show the cumulative results of multiple gears and unknown patterns of effort over time). It must also be recognized that disturbances from fishing are likely to be patchy within and between different habitats. The degree of patchiness as well as the frequency and intensity of the disturbance can greatly influence the effects of fishing in particular habitats. However, Auster and Langton (MS1998 and in press) have shown that the patterns and direction of impacts from small scale studies, and patterns seen in long-term studies of chronic impacts, are consistent with the results of those fewer research projects which determined the effects of fishing at the scale of fishing grounds. For example, Thrush et al. (in press) sampled multiple fishing grounds which were impacted by various degrees of fishing effort. The grounds subject to the most (highest) fishing effort had decreases in large epifauna and long-lived surface dwellers and an increase in deposit feeders and small opportunistic species, and reduced species diversity when compared to grounds with less fishing effort and areas closed to fishing. While the types and direction of impacts are known, rates of impacts based on particular levels of effort, produced by specific gear types, are not well understood. In order to clearly understand the effects of fishing on different types of habitat, areas currently closed and in an advanced stage of recovery would need to be used to experimentally determine effort-specific rates of impacts. Dorsey and Pederson (1998) suggest that research on the impacts of fishing gear in New England has been limited by the lack of unfished areas to compare with the fished areas, as well as by the high cost of conducting research on the sea floor.

Auster and Langton (MS1998 and in press) report that one of the most difficult issues regarding estimating the extent of fishing-related impacts on habitat is the lack of high resolution data on the distribution of fishing effort. Although data and information exists in a variety of formats and from a variety of sources (logbooks, interviews, observers), it is not consistent and represents only a portion of total fishing effort. This lack of information on the extent and frequency of the areas fished with particular gear types makes an assessment of the impacts of fishing activities on EFH difficult at best.

Auster and Langton (MS1998 and in press) demonstrate that one of the primary effects of bottom-tending mobile fishing gears is to reduce the complexity of the habitat. As fishing effort or intensity increases, the complexity of the habitat is reduced by removal of emergent epibenthic species (e.g., sponges, bryozoans, hydroids), smoothing of
sedimentary bedforms (e.g., sand waves and ripples), and removal of species which produce structures (e.g., crabs and fish which produce depressions and burrows). Maintaining habitat complexity is an important consideration, as many demersal species, especially juveniles, are associated with structural components in all habitats types. As the complexity of the habitat is reduced, these individuals are more likely to suffer higher levels of predation and fewer fish survive to recruit to the fishery. Habitat structure is more than just sediment type (e.g., mud, sand, gravel, boulder). While each sediment type varies in grain size (such that boulders provide deep crevices and sand can be used for burial), each also varies in types of bedforms and structures (e.g., mud burrows, sand waves) and the types of epifauna (e.g., burrowing anemones in mud; hydroids and amphipod tubes in sand; sponges and corals on gravel).

Based on the existing scientific literature, Auster and Langton (MS1998 and in press) present a model which integrates the range of effects observed in various studies. The model shows that the entire range of habitats from mud to boulders (except for pebble-cobble with no epifauna) can have a loss of complexity in the most impacted state. Sand wave fields can be smoothed, epifauna removed from sand and mud, epifauna removed from cobbles, and boulders moved to reduce the total amount of crevice space for boulder reef dwelling fishes (such as juvenile redfish). However, based on a method to score each habitat according to the level of complexity it provides, pebble-cobble with epifauna, piled boulders, and dispersed boulders-cobble are three categories of habitat showing the greatest reductions in habitat complexity from increasing fishing effort.

The issue of defining pelagic habitats and determining effects of fishing is difficult because these habitats are poorly described at the scales that allow for measurements of change based on gear use. While pelagic habitat can be defined based on temperature, light intensity, turbidity, oxygen concentration, currents, frontal boundaries, and a host of other oceanographic parameters and patterns, there are few published data that attempt to measure change in any of these types of parameters or conditions concurrent with fishing activity and associations of fishes. Kroger and Guthrie (1972) showed that menhaden (Brevortia patronus and B. tyrannus) were subjected to greater predation pressure, at least from visual predators, in clear versus turbid water, suggesting that turbid habitats were a greater refuge from predation. This same type of pattern was found for menhaden in both naturally turbid waters and in the turbid plumes generated by oyster shell dredging activities (Harper and Hopkins 1976). However, no work has been published that addresses the effects of variation in time and space of the plumes or the effects using turbid water refugia on feeding and growth.

There are also examples of small scale aggregations of fishes with biologic structures in the water column and at the surface. Aggregations of fishes may have two effects on predation patterns by: (1) reducing the probability of predation on individuals within the aggregation, and (2) providing a focal point for the activities of predators (a cue that fishermen use to set gear). For example, small fishes aggregate under mats of Sargassum (e.g., Moser et al. 1998) where high density vessel traffic may dis-aggregate mats. Also, fishes have been observed to co-occur with aggregations of gelatinous zooplankton and pelagic crustaceans (Auster et al. 1992, Brodeur in press). Gelatinous zooplankton are
greatly impacted as they pass through the mesh of either mobile or stationary gear (unpublished observations), which may reduce the size and number of aggregations and disperse associated fishes. These changes could reduce the value of aggregating, resulting in increased mortality or reduced feeding efficiency.

4.3 PROCESS

To complete an assessment of the current and potential adverse impacts to essential fish habitat associated with the various fishing-related activities occurring in the New England region, the Council used the following process:

1. **Identify all gears used in the New England fisheries.** This was completed by analyzing summary information from the NMFS commercial and recreational landings databases to identify any gear used to land a managed species during the fifteen-year time period, 1982 - 1996. Any gear type for which a minimum of 100 pounds was recorded during this time period is included. The list of gear types and this assessment includes the available information on recreational landings, correlated to the recreational fishing "mode" (shore, party/charter, or private/rental). [See Table 6.]

2. **Develop a list of all gears used, based on % of landings.** Landings for all gear types with recorded landings from 1982 - 1996 were totaled and the landings represented as a percentage of the total landings for that time period. Any gear identified as responsible for at least 1% of the landings is considered a primary gear type. [See Table 7.]

3. **Characterize the gears used in the New England region.** Information on the function, size, use and variations of the gears was developed.

4. **Identify the habitat impacts of the primary gears.** The Council is focusing the discussion of habitat impacts on the primary gears, using best available information as a reference, and correlating these impacts to generalized habitat types. Specific impacts, where known, of a particular gear type on a particular habitat type are identified.

5. **Focus consideration of mitigation measures on these areas.** Management action will most likely be limited to management measures available through the framework adjustment process, although the Council is considering several measures which will mitigate some of the adverse effects of fishing activity on EFH.

6. **Other issues.** The Council is also assessing the habitat impacts from aquaculture, "ghost" fishing gear and marine debris, and off-shore fish processing. These are activities / issues that have been identified as potential fishing-related impacts to essential fish habitat. All other activities that have the potential to adversely impact habitat are considered to be non-fishing related activities and are addressed in the non-fishing impacts section.

The Council's assessment of fishing-related activities includes the following:
• identification and characterization of fishing gears used in New England -- this section identifies the various gear types used to harvest the species managed by the Council and describes the form and function of the gear types.
• assessment of the effects on habitat from fishing-related marine debris and "ghost" gear.
• assessment of the effects on habitat from aquaculture.
• assessment of the effects on habitat that are likely to occur from at-sea fish processing.
• assessment of existing and new management measures implemented by the Council that either directly or indirectly protect and conserve EFH from the effects of fishing-related activities.
• description of measures to protect the area designated as a habitat area of particular concern for juvenile Atlantic cod.
• description of the Council's process for developing and implementing framework adjustment measures for EFH.
• "The Effects of Fishing on Habitat," a synthesis of the effects of fishing on fish habitat produced to aid the fishery management councils in assessing the impacts of fishing activities, prepared by Peter J. Auster of the National Undersea Research Center, and Richard W. Langton of the Maine Department of Marine Resources (included as Appendix E).

4.4 GEAR IMPACTS ASSESSMENT

Auster and Langton (1998 and in press) showed there is very little information on impacts to habitat associated with several gear types used in the New England region, principally gillnets, longlines, haul seines, hand lines, mid-water trawls, purse seines, and stop seines. Gear types designed to work in mid-water do not impact the seafloor but may effect mid-water aggregations of gelatinous zooplankton which has been demonstrated to serve as habitat for some species. Other gear types which fish in a static fashion on the seafloor such as traps, gillnets and longlines are thought to minimally impact the seabed. However, the cumulative effects of static gear remain unknown. It is important to remember, however, that the impacts of fishing gear depend not only on the type of gear used, but also the frequency and intensity of use, the type of bottom and the composition of the benthic community. Taking these considerations into account, the bottom-tending mobile gears (otter trawls, scallop dredges, beam trawls, and hydraulic clam dredges) are most likely to be associated with adverse impacts to habitat. Jones (1992) suggests that beam trawls, otter trawls, and dredges are all essentially similar in impact, and the severity of the impact can be correlated to the weight of the gear that is in contact with the bottom. The heavier the gear in contact with the bottom, the greater the impact. This may be an oversimplification, but it illustrates an important point -- the lighter the gear, the less impact it is likely to have.

Most research on gear impacts has been done on beam trawls, otter trawls, and scallop
dredges, which contribute to the majority of landings in the New England fisheries. The impacts that can presently be deduced to affect fish populations occur on the relatively more complex habitat types, such as cobble, shell, or rock (Auster and Langton MS1998 and in press). These impacts are especially acute in the presence of emergent epifauna or other biogenic structure (Auster and Langton MS1998 and in press). It is clear that current scientific knowledge can predict the types and direction of impacts from high levels of fishing effort with mobile gear types which would allow managers to take precautionary approaches.

4.5 FISHING GEARS USED IN THE NEW ENGLAND AREA

Based on a review of the National Marine Fisheries Service commercial fisheries landings data for the species managed by the New England Fishery Management Council, forty-three categories of fishing gear were identified as having been associated with landings during the fifteen-year period between 1982 and 1996. Table 6 displays the forty-three gear types and indicates the species landed. These gear types were identified as having been used to land a minimum of one hundred pounds of at least one species, either as a target catch or bycatch. Any gears with less than one hundred pounds of landings are not considered here. The categories of fishing gears are taken from the NMFS commercial and recreational landings databases. An "X" indicates that the gear type is associated with at least one hundred pounds of landings of the species at some time during the fifteen year assessment period (1982 - 1996).

Gears of primary concern in an analysis of the impacts of fishing activity on essential fish habitat are those identified as having been used to land at least one percent of all landings of at least one species during the same fifteen year time frame. Table 7 provides the percentage landings associated with each gear type for each species landed. Eighteen gear types are considered primary gears, and these will be examined in more detail, including an assessment of the likely impact the gears have on essential fish habitat. This assessment is based on a review of the current literature on fishing impacts to the seafloor.

Table 7 summarizes the percent of total landings of each managed species associated with each gear type used in the fishery. For example, the sea scallop dredge (listed as "dredge scallop, sea") accounted for 32% of the monkfish landings from 1982 - 1996, 6% of the yellowtail flounder landings, 3% of the windowpane flounder landings, 2% of the winter flounder landings, 1% each of the landings of American plaice and witch flounder, and 95% of the landings of sea scallops. The three gear types that accounted for the top percentages of landings for each species were the otter trawl, scallop dredge, and purse seine. However, the otter trawl accounted for the majority of catch for all species except sea scallops and Atlantic herring.

Many gears only accounted for a trace amount of landings (less than 0.5%) and these are indicated by a "+". Several gear types (dip nets, diving outfits, crab dredges, sea urchin dredges, bay scallop dredges, fykes and hoop nets, pound nets, mackerel purse seines, spears, trammel nets, stop nets, and jigging machines) accounted for only trace amounts of landings for fewer than five species and were not included in the table.
Recreational fishing is also a consideration when examining the effects of fishing on the habitat. The available information on recreational landings were examined and incorporated into this assessment. Tables 6 and 7 include recreational fishing, identified by fishing mode -- shore, party/charter, or private/rental. Additional information would be required to complete a more comprehensive assessment of the effects of recreational fishing on essential fish habitat.
Table 6: Types of Fishing Gears Used in New England Fisheries *

| Gear Type                  | Beam trawls | dip nets | diving outfits | dredge clam | dredge crab | dredge scallop, bay | dredge scallop, sea | dredge urchin, sea | floating traps, shallow | fyke and hoop nets | gin nets | gillnets, drift, other | gillnets, stake | haul seine, beach | haul seine, long | lines hand, other | lines jugging machine | lines long set with hooks | lines troll, other | lines trawl, bottom, crab | lines trawl, bottom, lobster | lines trawl, bottom, fish | lines trawl, bottom, other | lines trawl, bottom, scallop | lines trawl, bottom, shrimp | lines trawl, mid-water, pots and traps | pot nets | pound nets | fish | pound nets, other | purse seine, fishing | purse seine, herring | purse seine, mackerel | purse seine, other | recreational, charter | recreational, party/charter | recreational, private/rental | scottish seine | spears | stop nets | stop seine | trawl bottom, paired | trawl mid-water, paired | weirs |
|----------------------------|-------------|----------|----------------|-------------|-------------|---------------------|---------------------|---------------------|------------------------|----------------------|----------|------------------------|----------------|---------------------|----------------|----------------|------------------|----------------|------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| American plaice            | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| Atlantic halibut           | X           |          |                |             |             | X                   | X                   | X                   |                        |                      | X        |                        | X              |                     |                |                |                  |                |                  |                |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |
| Atlantic cod               | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| flounder, windowpane      | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| flounder, winter          | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| flounder, witch           | X           | X        | X              | X           | X           | X                   |                        | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| flounder, yellowtail      | X           | X        |                |             | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| haddock                   | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| hake, red                 | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| hake, white               | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| Atlantic herring          | X           | X        | X              | X           | X           | X                   |                       | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| monkfish                  | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| ocean pout                | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| pollock                   | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| redfish                   | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| sea scallop               | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |
| whiting                   | X           | X        | X              | X           | X           | X                   | X                   | X                   | X                      | X                    | X        | X                      | X              | X                   | X              | X              | X                | X              | X                | X              | X                | X                | X                | X                | X                | X                | X                | X                |

* Based on the categories used in the NMFS Commercial and Recreational Landings Database, from 1982 - 1996.
Table 7: Percentage of Landings for Each Fishing Gear Type Used in the New England Fisheries, 1982 - 1996 * (1000's of pounds total landings from 1982 - 1996 in parentheses)

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*"+" Indicates that there were trace (< 0.5 %) landings associated with this gear type for this species.

*"-" Indicates that there were no landings recorded for this gear type for this species.
Much of the following information is taken from either *Commercial Fishing Methods: An introduction to vessels and gears*, (3rd Ed.) by John C. Sainsbury or was provided by Dr. Joseph DeAlteris, University of Rhode Island.

**Beam Trawls**

The beam trawl is essentially a trawl net much like an otter trawl, only the net is spread horizontally by a wooden or steel beam that runs the horizontal width of the trawl rather than with otter boards. The trawl net is spread vertically by heavy steel trawl heads that generally have skid-type devices with a heavy shoe attached. The otter boards and quarter ropes of the more common otter trawl are not needed. The net’s headrope is fastened directly to the beam and the groundrope is connected loosely between the bases of the shoes. Modern beam trawls range in size from 4 to 12 meters beam width and the beam is held about 1 meter above the bottom. Depending on the ground being fished, beam trawl nets may be fitted with a number of tickler chains or a heavy chain mat. The tickler chains are usually rigged between the ends of the shoes to dig out fish lying on or buried in sand and mud and the number of chains that will be used depends on the species being targeted. A chain mat is generally used in place of the tickler chains on hard and rocky grounds.

Towing speeds of at least five knots are generally considered most effective for the capture of flatfish with a beam trawl. The advantages claimed for beam trawls over otter trawls in catching demersal species, especially flatfish include:

- The warp length has less influence on performance;
- The size of the net opening remains constant during turns;
- The effectiveness of the gear is less affected by soft muddy bottoms;
- The gear has less drag (reducing the power required); and,

Smaller vessels with restricted warp capacity can fish deeper since less scope is needed. Modern beam trawlers often use double beam trawls, in which two beam trawls are towed from heavy booms rigged from a large A-frame mounted to the deck of the vessel. Additional recent modifications to this gear type include:

- Replacing the chain mat with an electrode array fed by an on-board generator;
- Replacing the trawl head shoes with wheels; and,
- The development of a high-lift net design where the headline is not attached to the beam but rather allowed to billow upwards.


**Dip Nets**

Dip nets are relatively small, handled nets used to scoop fish from the water.
Diving Outfits

By either free diving or using SCUBA, divers collect crustaceans, mollusks and some reef fish in shallow water. Most often a support vessel is used to transport the diver(s) to the fishing site and carry the landings to port. In deeper waters, helmet diving systems are used and the diver is tethered to the vessel with air pumped from the surface. This method is most often used by sea urchin divers and some lobster divers. Divers normally use small rakes or hoes to scrape creatures off rocks or dig them out of the seabed. Generally, the catch is placed in bags which are either towed to the surface by the boat or floated to the surface using an air source and a lift bag. Divers rarely work deeper than about 50 meters. (Sainsbury 1996)

Clam Dredge

To dig up clams from out of the sediment, hydraulic dredging is often used. In hydraulic dredging, high pressure water jets ahead of the rake teeth or blade are used to scour out the shells which are then dug up by the blades and passed back into the bag. High pressure water is supplied to the jets through a hose from the operating vessel by a diesel pump and the bag is generally carried on a heavy sled. This gear is generally fished in relatively shallow inshore and estuarine areas. (Sainsbury 1996)

In the ocean surf clam fishery, large vessels (>30 m), tow dredges up to 4.5 m in width slowly across the seabed. The vessels are equipped with large pumps, connected to the dredges via flexible hoses, that use water and inject it into the sediment through a manifold with multiple nozzles, ahead of the blade of the dredge. The dredge must be towed slowly so as to not exceed the liquification rate. These dredges, operated correctly, are highly efficient, taking as much as 90% of clams in their path. In the estuarine soft-clam fishery, the dredge head (manifold and blade) is attached to an escalator that continuously carries the materials retained on the blade to the working deck of the vessel to be selected by the fishermen. These vessels are restricted to water depths less than one-half the length of the escalator. However, the soft clam is a shallow water clam, so the technology is most appropriate and is typically operated from 15 m vessels in water depths of 2-6 m. (DeAlteris, J. 1998. Training Manual: Fisheries Science and Technology, prepared for the NOAA Corps Officer Program.)

Crab Dredge

Crabs are harvested during the winter months with dredges similar to oyster dredges. The oyster dredge consists of a steel frame 0.5-2.0 m in width, with an eye and “nose” or “tongue,” and a blade with teeth. Attached to the frame is the tow chain or wire, and a bag to collect the catch. The bag is constructed of rings and chain-links on the bottom to reduce the abrasive effects of the seabed, and twine or webbing on top. The dredge is towed slowly (<1 m/sec) in circles, from vessels 7 to 30 m in length. Stern-rig dredge boats (∼ 15 m in length) tow two dredges in tandem from a single chain warp. The dredges are equipped with long teeth (10 cm) that rake the crabs out of the bottom. (DeAlteris 1998)
Bay Scallop Dredge

Since scallops usually lie on the bottom, on clear bottoms no raking teeth are needed, and the dredge is actually quite a simple gear. The bay scallop dredge may be 1 to 1 1/2 meters wide and about twice as long. The simplest bay scallop dredge can be just a mesh bag attached to metal frame that is pulled along the bottom. For bay scallops that are located on sand and pebble ground, a small set of raking teeth are set on a steel frame, and skids are used to align the teeth and the bag. (Sainsbury 1996)

Sea Scallop Dredge

In the open ocean, a larger dredge is used to harvest sea scallops. Scallops inhabit sandy, gravelly, and cobble bottom, and live on the surface of the sea bed as epifauna. Scallops are mobile animals and can evade a dredge approaching too slowly. Therefore, scallop dredges have to be towed at speeds up to 2.5 m/sec. The scallop dredge includes a steel frame with a tongue with an eye, a blade with no teeth, and a bag. Scallop dredges are usually defined by the width of the dredge frame, the width or mouth opening of which ranges from 1 - 4.5 meters, with the weight of the dredge varying from 20 to 1000 kg. The New Bedford style dredge is usually between 4 and 4.5 meters wide. The front of the steel frame of the dredge, called the bale, usually rides up off the bottom. The bottom of the frame is called the cutting bar and it tends to ride up off the bottom about four inches on flat, smooth bottoms. On rougher bottoms, the cutting bar will come in contact with the higher areas of the sea floor.

There is a chain sweep that attaches to the ends of the frame at the shoes, reinforced bottom pads. The bag of the dredge is known as a "ring bag" and is made of rings and chain-links on the bottom and webbing on top. Using a scallop dredge on hard bottom usually requires the addition of "rock chains" that run front to back, along with the side-to-side tickler chains used on all types of scallop dredges. The rougher the bottom, the more rock chains are used, to prevent rocks and boulders from getting into the ring bag. Selectivity of the dredge is controlled by the size of the rings in the ring bag. The smallest dredges are towed by 6 m vessels and hauled by hand. The largest scallop vessels, about 30 m in length, tow two 4.5 meter dredges, one from each side of the vessel, and use winches and navigational electronics to maintain high efficiency. (DeAlteris 1998 and Smolowitz 1998)

Sea Urchin Dredge

Similar to a simple bay scallop dredge, the sea urchin dredge is designed to avoid damaging the catch. It consists of an up-turned sled-like shape at the front that includes several leaf springs tied together with a steel bar. A tow bail is welded to one of the springs and a chain mat is rigged behind the mouth box frame. The frame is fitted with skids or wheels. The springs act as runners, enabling the sled to move over rocks without hanging up. The chain mat scrapes up the urchins. The bag is fitted with a codend for ease of emptying. This gear is generally only used in waters up to 100 meters deep. (Sainsbury 1996)
Shallow Floating Traps

In New England, because of the rocky shoreline and shallow subtidal environment, stakes can not be driven into the bottom, so the webbing is supported by floats at the sea surface, and held in place with large anchors. These traps are locally referred to as “floating traps.” The catch, design elements and scale of these floating traps is similar to pound nets. (DeAlteris 1998)

The floating trap is designed to fish from top to bottom, and is built especially to suit its location. The trap is held in position by a series of anchors and buoys. The net is usually somewhat “T-shaped,” with the long portion of the net (the leader net) designed to funnel fish into a box of net at the top of the T. The leader net is often made fast to a ring bolt ashore. (Sainsbury 1996)

Fyke and Hoop Nets

Constructed of wood or metal hoops covered with netting, hoop nets are long (2.5 - 5 meter) nets, “Y-shaped” with wings at the entrance and one or more internal funnels to direct fish inside, where they become trapped. Occasionally, a long leader is used to direct fish to the entrance. Fish are removed by lifting the rear end out of the water and loosening a rope securing the closed end. These nets are generally fished to about 50 meters deep. (Sainsbury 1996)

On a smaller scale, a fyke trap is a small, unbaited cylindrical pot that includes the addition of a leader and heart to direct migrating fish into the funnel of the pot. This gear is set in shallow ponds and estuarine embayments for animals migrating in this habitat. The leader, constructed of webbing supported by stakes is only 10-30 m in length and 1-2 m in height. The trap is cylindrical, constructed of hoops 1-2 m in diameter, surrounded by webbing with 1-2 funnels, non-return devices, leading into the conical holding area. (DeAlteris 1998)

Drift Gill Nets, Other

Gillnets operate principally by wedging and gilling fish, and secondarily by entangling. The nets are a single wall of webbing, with float and lead lines. The nets are designed and rigged to operate as either sink or floating nets, and are anchored or drifting. The webbing is usually monofilament nylon due to its transparency; but multifilament, synthetic or natural fibers, are also used. Drift gillnets are designed so as to float from the sea surface and extend downward into the water column and are used to catch pelagic fish. In this case the buoyancy of the floatline exceeds the weight of the leadline. Floating gillnets are anchored at one end or set-out to drift usually with the fishing vessel attached at one end. (DeAlteris 1998)

Sink/Anchor Gill Nets, Other

Anchored sink gillnets are used to harvest demersal fish along all coasts of the U.S. The nets are rigged so that the weight of the leadline exceeds the buoyancy of the floatline,
thus the net tends the seabed, and fishes into the near bottom water column. Anchors are used at either ends of the net to hold the gear in a fixed location. The nets vary in length from 100 to 200 m, and in depth from 2-10 m. Multiple nets are attached together to form a string of nets, up to 2000 m in length. In shallow water, sink gillnets may fish from bottom to surface, if the webbing is of sufficient depth. (DeAlteris 1998)

**Stake Gill Nets**

Generally a small boat, inshore method in which a gill net is set across a tidal flow and is lifted at slack tide to remove fish. Wooden or metal stakes run from the surface of the water into the sediment and are placed every few meters along the net to hold it in place. When the net is lifted, the stakes remain in place. These nets are generally fished from the surface to about 50 meters deep. (Sainsbury 1996)

**Beach Haul Seines**

The beach seine resembles a wall of netting of sufficient depth to fish from the sea surface to the sea bed, with mesh small enough that the fish do not become gilled. A floatline runs along the top to provide floatation and a leadline with a large number of weights attached ensures that the net maintains good contact with the bottom. Tow lines are fitted to both ends. The use of a beach seine generally starts with the net on the beach. One end is pulled away from the beach, usually with a small skiff or dory, and is taken out and around and finally back in to shore. Each end of the net is then pulled in towards the beach, concentrating the fish in the middle of the net. This is eventually brought onshore as well and the fish removed. This gear is generally used in relatively shallow inshore areas. (Sainsbury 1996)

**Long Haul Seines**

The long-haul seine is set and hauled in shallow water estuaries from a boat (about 15 m). The net is a single wall of small mesh webbing (< 5 cm), and is usually greater than 400 m in length and about 3 m in depth. The end of the net is attached to a pole driven into the bottom, and the net is set in a circle so as to surround fish feeding on the tidal flat. After closing the circle, the net is hauled into the boat, reducing the size of the circle, and concentrating the fish. Finally, the live fish are brailed or dip-netted out of the net. (DeAlteris 1998)

**Hand Lines, Other**

The simplest form of hook and line fishing is the hand line. It consists of a line, sinker, leader and at least one hook. The line is usually stored on a small spool and rack and can vary in length from 1-102 m. The line varies in material from a natural fiber to synthetic nylon. The sinkers vary from stones to cast lead. The hooks are single to multiple arrangements in umbrella rigs. An attraction device must be incorporated into the hook, usually a natural bait and artificial lure. There are both recreational and commercial hand line fisheries in the U.S. In fact, although this is a technologically sophisticated fishery with fish finding and navigation electronics, it is still conducted by individual or pairs of
fishermen in small boats (<10m), so it may be considered an artisanal fishery. Operationally, hand lines offered a high degree of efficiency, so that the fisherman is able to feel the fish bite the bait, and then set the hook. Hand lines can be used as a fixed or static gear or towed as a mobile gear. Hand lines are usually a passive gear because the fisherman attracts the target, and the fish then voluntarily takes the hook. However, in certain cases, if the hand line is equipped with a treble or ripper hook, then the hand line becomes an active device, as the hook snags the prey. (DeAlteris 1998)

**Jigging Machine Lines**

Mechanized line hauling systems have been developed to allow more lines to be worked by smaller crews. Electric or hydraulic reel systems, termed bandits, are mounted on the vessel bulwarks. The reels have a spool around which the mainline is wound. Each line may have a number of branches and baited hooks, and the line is taken from the spool over a block at the end of a flexible arm. The vessel’s movement combined with the flexible arm provides a fishing action to the line and the hooks. This gear is used to target several species of groundfish, especially cod and pollock and it has the advantage of being effective in areas where other gears cannot be used. Jigging machine lines are generally fished in waters up to 600 meters deep. (Sainsbury 1996)

**Long Lines Set with Hooks**

*Bottom Longline Gear:* With the guiding philosophy that if one hook is good, many hooks are better, commercial fishermen developed bottom longline gear. The principle element of this gear is the mainline or groundline that can extend up to 50 km in length. Branching off the mainline at regular intervals are leaders or snoods, and hooks. Anchors hold each end of the mainline in place, and surface buoys attached via float lines to the anchors mark the location of the gear. The mainline was initially constructed of natural fiber lines, that was replaced by a hard-lay, twisted, tarred nylon, and now monofilament and wire cables are typically used. Leaders were initially tied to the mainline, and now they typically snap on to the mainline allowing separate storage of the hooks and leaders and the mainline. All bottom-set, longline gear is considered fixed and passive because once deployed the gear does not move, and the fish voluntarily takes the hook.

In the early 1900s, fishermen on the northwest Atlantic banks, set longlines from dories deployed from sailing schooners. The longlines were stored in tubs or baskets neatly coiled with hooks placed around the outside perimeter of the tub (hence, the term “tub trawling”). Nearly 100 years later this form of fishing continues aboard intermediate-sized coastal vessels fishing for cod and other species. Today, longliners typically use a groundline of approximately 1800 feet per tub of gear. A single set typically consists of connecting from two to four tubs of gear. The groundline is heavy parachute cord with gangions (leaders) spaced at roughly six foot intervals. Usually, the hooks are baited on shore.

Some boats have replaced the tubs with large, hydraulically powered reels as the storage device for the mainline, and leaders with their hooks are snapped onto or off
the mainline as the gear is set or hauled respectively. The tilefish fishery on the U.S. east coast uses this type of gear, and a typical 25 m vessel sets and hauls 50 km of mainline with thousands of hooks set and hauled daily, while operating in the canyons on the edge of the continental shelf. More mechanized bottom longline systems have been developed in Norway by Mustad for operation by large vessels (> 25 m). These auto-line systems include baiting machines, variable hook spacing, etc., and enable these vessels to fish up to 10,000 hooks per day. (DeAlteris 1998)

*Pelagic Longline Gear:* An evolution from bottom longline gear was the development of pelagic longline fishing methods. The mainline is suspended at depth from buoys and dropper lines, with the minimum depth (about 20 m), being that required to avoid entanglement by coastal maritime traffic. The length of the mainline varies from 300 to 100 km depending on the size of the vessel. The mainline material began as 3-strand twisted, hard-lay, tarred nylon, but has been entirely replaced by monofilament. The line is stored on a reel equipped with a level-winder to prevent tangles on the reels. Hooks, leaders and dropper lines are stored on small reels end to end. If the mainline is set level at a fixed depth, then the leader length varies from 2-40 m, so as to ensure the hooks are distributed over a range of depths. If a line-shooter is used to set the mainline in a catenary shape with regard to depth, then the leaders are usually a single minimal length, but are still distributed by depth. (DeAlteris 1998)

*Troll Lines, Other*

Essentially, trolling involves the use of a baited hook or lure maintained at a desired speed and depth in the water. Usually, two to four or more lines are spread to varying widths by the use of outrigger poles connected to the deck by hinged plates. Line retrieval is often accomplished by means of a mechanized spool. Each line is weighted to accomplish the desired depth and may have any number of leaders attached, each with a hook and bait or appropriate lure. This gear is generally fished from the surface to about 20 meters. (Sainsbury 1996)

*Bottom Otter Trawl (fish)*

Otter trawls developed as fishermen sought to further increase the horizontal opening of the trawl mouth, but without the cumbersome rigid beam. In the late 1880s, Musgrave invented the otter board, a water-plane device that when used in pairs, each towed from a separate wire, served to open the net mouth horizontally and hold the net on the bottom. Initially, all otter boards were connected to the wing ends of the trawl, as they are today in the shrimp trawl fishery. In the 1930s, the Dan Leno gear was developed by Frenchmen, Vigarnon and Dahl, that allowed the otter boards (doors) to be separated from the trawl wing ends using cables or “ground gear.” This technology increased the effective area swept by trawl from the distance between the net wings to the distance between the doors. The ground gear can be as long as 200 m, thus increasing the area swept by the trawl by as much as three fold. It is the spreading action of the doors resulting from the angle at which they are mounted that creates the hydrodynamic forces needed to push them apart. These forces also push them down towards the sea floor. On
fine-grained sediments, the doors also function to create a silt cloud that aids in herding fish into the mouth of the trawl net (Carr and Milliken 1998).

The bottom trawl net is a funnel-shaped net composed of upper and lower sections joined at seams referred to as “gores”. Some bottom trawls also have side panels to increase the vertical opening, and therefore have four seams. The mouth of the trawl net consists of jib and wing sections in both the upper and lower panels. A “square” section forms a roof over the net mouth. The body of the trawl net includes belly sections, leading to the cod-end where the catch is collected. The webbing is attached to a rope frame consisting of a headrope, along the upper panel leading edge, and a footrope, along the lower panel leading edge. The sweep which tends bottom as the net is towed, is attached to the footrope. The headrope is equipped with floats that provide buoyancy to open the net mouth vertically. The headrope and footrope/sweep are attached to bridles (also referred to as legs) at the wing ends, that lead to the ground wires and the trawl doors. The sweep also comes in contact with the bottom as it acts to collect fish that lie or congregate before it. The configuration of the sweep can vary considerably and is dependent upon both the bottom type and species of fish targeted (Carr and Milliken 1998).

On smooth bottoms, the footrope may be weighted with chain or leadline, or may be rope wrapped with wire. This is the simplest and lightest sweep, known as a chain sweep. On soft or slightly irregular bottoms, rubber discs (known as "cookies") stamped from automobile tires can be strung along the sweep (Carr and Milliken 1998). On rougher bottoms, rubber rollers or steel bobbins are rigged to the footrope to assist the trawl's passage over the bottom. Both the rollers and the bobbins use small steel or rubber spacers between the much larger roller and bobbins. In New England, the rollers have been largely replaced with "rockhopper" gear, that uses larger rollers that are actually fixed in place, spaced with the smaller rubber discs (Carr and Milliken 1998). This setup enables the trawl to pass over, yet still effectively fish, areas with large rocks and boulders.

A newly developed gear known as "street-sweeper" trawl gear, is constructed of a series of rubber disc spacers and bristle brushes, as found in actual street sweepers. The distinguishing component of this sweep is the brushes made of stiff bristles mounted on a cylinder core. The brush cylinders are up to 31 inches in diameter and have smaller diameter rubber disc(s) placed between them. The discs are strung on a cable or chain and aligned in series forming the sweep of the trawl net. This innovation probably allows the trawl to be fished on rougher bottom than any other design and it is lighter than the rockhopper (Carr and Milliken 1998).

The raised-footrope trawl was designed especially for fishing for whiting, red hake, and dogfish. It was designed to provide vessels with a means of continuing to fish for small mesh species without catching groundfish. The configuration consists of a 42 inch long chain connecting the sweep to the footrope, which results in the trawl fishing about 18 - 24 inches above the bottom (Carr and Milliken 1998). The raised footrope keeps the net slightly above the bottom, allowing complete flatfish escapement, and theoretically it is supposed to travel over codfish and other roundfish (whiting and red hake tend to swim
slightly above the other groundfish). Carr and Milliken (1998) report that studies have confirmed that the raised footrope sweep has much less contact with the sea floor that does the traditional cookie sweep that it replaces.

Bottom trawl vessels are classified as to the location of the pilothouse, and manner in which the net is set and hauled. Eastern rig vessels handle the trawl gear from the side of the vessel and the pilothouse is located aft of the working deck. Western rig vessels handle the trawl gear over the stern of the vessel and the pilothouse is forward of the working deck. Most western rig or stern trawlers stow the trawl net on a reel located at the stern of the vessel.

Bottom trawl fisheries are prosecuted for demersal species on all coasts of the U.S. In the northeast, vessels from 15 to 50 m fish in waters ranging from 10 to 400 m in depth. Small mesh nets are used to capture northern shrimp, whiting, butterfish and squid. Large mesh trawls are used to harvest cod, haddock, flounder and other large species. These trawls are typically rigged with long ground wires that create sand clouds on the seafloor, herding the fish into the trawl mouth. The largest trawlers, from 50-100 m in length, catch, process and freeze their products onboard, and are referred to as factory, catcher, processor trawlers. (DeAlteris 1998)

**Bottom Otter Trawl (crab)** See the description above for Otter Trawls.

**Bottom Otter Trawl (lobster)** See the description above for Otter Trawls.

**Bottom Otter Trawl (other)** See the description above for Otter Trawls.

**Bottom Otter Trawl (scallop)** See the description above for Otter Trawls.

**Bottom Otter Trawl (shrimp)**

In the southeast and Gulf coast areas, small mesh trawls are used to harvest shrimp. Because shrimp can not be herded, shrimp trawl nets are usually connected directly to the trawl doors. Southern shrimp trawl vessels tow 2-4 trawls from large booms extended from each side of the vessel. (DeAlteris 1998)

**Midwater Otter Trawl**

Pelagic fishes are harvested using off-bottom or midwater trawl nets. The nets must be aimed or directed at specific concentrations of fish. Therefore, the fishermen must be able to identify the location of fish both laterally and vertically, and to direct the pelagic trawl to that position. Hydroacoustic instruments are used to locate both fish and the fishing gear. Sonar, a forward searching acoustic device is initially used to locate the fish ahead of the vessel. As the fisherman directs the vessel over the fish, the echosounder is used to verify the exact size and depth of the school. As the fisherman is approaching fish, he is also using the net sounder, an acoustic device on the pelagic trawl mouth, to determine the depth and vertical opening of the trawl. By adjusting the length of the tow warp and speed of the tow vessel, the fishing depth of the trawl mouth is adjusted to
match the depth of the fish. In general, pelagic fish have a high visual acuity and are fast swimmers, so pelagic trawls are very large and must be towed fast. Thus, pelagic trawl vessels, must be equipped with relatively more horsepower than similarly sized demersal trawlers.

The pelagic trawl mouth is opened horizontally by high aspect otter boards, that act as foils or wings oriented vertically in the water column. The net initially is opened vertically, by the floats along the headrope and weights along the footrope. After stabilizing position in the water column, water flow acting on the tapered panels of the funnel shaped net opens the net. The net is always constructed of four panels, with a gentle taper, so as to appear as an endless tunnel to the fish. Generally, the net employs webbing of multiple mesh sizes, the largest in the jibs and forward bellies, reducing to smaller mesh sizes in aft bellies, and the smallest mesh size in the cod-end, suitable for retaining the target species. (DeAlteris 1998)

Pots and Traps

The essential element of any pot or trap fishing gear is a non-return device, that allows the animal to voluntarily enter the gear, but makes escape difficult, if not impossible. The terminology used to identify pots and traps is also confusing, as both terms have been applied to the small portable, 3-dimensional gear. In this document, a pot is defined as a small, portable, 3-dimensional device, whereas a trap is identified as large, permanent, 2-dimensional gear.

**Pots:** The principle of operation of pot gear is that animals enter the device seeking food, shelter, or both. The non-return device, while allowing the animal to enter the gear, restricts escape. The holding area retains the catch until the gear is retrieved. Bait is placed in a bag or cage within the pot. Culling rings or escape vents are added to the exterior wall of the pot to allow for the release of undersize sub-legal animals. Finfish, shellfish and crustaceans are all harvested with pots in the estuarine, coastal and offshore waters of the U.S.

Clawed lobsters are harvested with pots in the waters of the northwest Atlantic. The pots were previously constructed of wood lath over steam bent frames, but because wood boring bivalves destroy wood, in many cases vinyl coated wire pots have replaced them. Cost is another factor leading to the switch to vinyl coated wire pots. The pots are typically divided into two sections. Lobsters enter the pot into the “kitchen area,” via either of two funnels in response to the bait, then move into the “parlor” area via a second funnel. Escape vents, sized to minimize the retention of sub-legal lobsters are occasionally installed in both areas of the pot. The pots are fished individually or in “trawls” attached to a mainline in shallow water, and only in trawls of 20-50 pots in deep water. Buoy lines mark both the single pots, and the ends of the trawls of pots. Fishermen haul pots either by hand in shallow water, or use an hydraulically powered pot hauler in both shallow and deep water. The pot hauler was a significant mechanization introduced into the pot fishery, that allowed for the development of deep water fisheries.
The crab fisheries conducted in the inshore waters of the mid and south Atlantic regions also use a wire mesh pot. The design of the pot incorporates two sections, an “upstairs” and “downstairs.” Crabs attracted by bait, enter the “downstairs” via one of two-four entrance funnels. Once in the pot, the escape reaction is to swim upward, so a partition with two funnels separates the two sections. The “upstairs” section serves to hold the catch for harvest. Escape vents or cull rings may be installed in the pot to reduce juvenile by-catch. Crab pots are always fished as singles and are hauled by hand from small boats, or with a pot hauler in larger vessels. Crab pots are generally fished after an overnight soak, except early and late in the season. (DeAlteris 1998)

Trap Gear: Traps are generally a large scale, 2-dimensional device that use the seabed and sea surface as boundaries for the vertical dimension. The gear is fixed, that is installed at a location for a season, and is passive, as the animals voluntarily enter the gear. Traps consist of a leader or fence, that interrupts the coast parallel migratory pattern of the target prey, a heart or parlor that leads fish via a funnel into the bay section, and a bay or trap section that serves to hold the catch for harvest by the fishermen. The non-return device is the funnel linking the heart and bay sections. The bay, if constructed of webbing, is harvested by concentrating the catch in one corner, a process referred to as “bagging” or “hardening” the net.” The catch is removed by “brailing,” with a dip net. The advantages of traps are that the catch is alive when harvested, resulting in high quality, that the gear is very fuel efficient, and that there is the potential for very large catches. The disadvantages are that the initial cost of the gear is high, that there is competition for space by other users of the estuarine and coastal ecosystem, and finally that the fish must pass by the gear to be captured, so any alterations in migratory routes will radically affect catch.

Fish Pound Nets

Pound nets are constructed of netting staked into the sea bed by driven piles. Pound nets have three sections: the leader, the heart, and the pound. The leader (there may be more than one) may be as long as 400 meters and is used to direct fish into the heart(s). One or more hearts are used to further funnel fish into the pound and prevent escapement. The pound may be 15 meters square and is the hold for the fish until the net is emptied. These nets are generally fished in waters less than 50 meters deep. (Sainsbury 1996)

Purse Seines, Other

The purse seine is an evolution of the ring net. The ring net is a single wall of webbing that is also used to surround concentrations of pelagic fish. A discontinuous line, the hauling rope, attached to the center bunt section of the net, is used to close the bottom of the net after a school of fish has been circled. The ring net is usually a relatively small net (about 200 m in length) and is typically used in fresh water fisheries. The discontinuous hauling line has been replaced by a continuous purse line. Functionally, purse seines are used to surround a concentration of fish, then the purse seine is hauled in
so as to close the bottom of the net. Critical aspects of the design and operation of a purse seine include:

- sufficient weight on the leadline to achieve a rapid submersion of the net.
- adequate floatation to support the webbing and leadline.
- the net must be of correct length to allow for the complete enclosure of the school of fish.
- the mesh size must neither be too big so as to allow escape or gilling of fish, and not so small as to create excess bulk and drag.

The puretic power block developed in the early 1950s, was a significant mechanization of the purse seine fishery. The V-shaped sheave, attached to a beam end, and powered by a hydraulic motor, has replaced 10-20 men that used to haul in the long wings of the small seines (300 m) used to harvest menhaden in Chesapeake Bay. The largest purse seines now used on tuna fish in the open ocean are more than 2000 m in length and 200 m in depth. Without the power block, these fisheries would not have developed. (DeAlteris 1998)

**Herring Purse Seines** See the description above for Purse Seines.

**Mackerel Purse Seines** See the description above for Purse Seines.

**Scottish Seine**

Danish seining or anchor dragging was developed in the 1850s prior to the advent of otter trawling. The Danish seine is a bag net with long wings, that includes long warps set out on the seabed enclosing a defined area. As the warps are retrieved, the enclosed area (a triangle) reduces in size. The warps dragging along the bottom herd the fish into a smaller area, and eventually into the net mouth. The gear is deployed by setting out one warp, the net, then the other warp. On retrieval of the gear, the vessel is anchored. This technique of fishing is aimed at specific schools of fish located on smooth bottom. In contrast to Danish seining, if the vessel tows ahead while retrieving the gear, then this is referred to as Scottish Seining or fly-dragging. This method of fishing is considered more appropriate for working small areas of smooth bottom, surrounded by rough bottom. Scottish and Danish seines have been used experimentally in U.S. demersal fisheries. Space conflicts with other mobile and fixed gears, have precluded the further development of this gear in the U.S., as compared to Northern Europe. (DeAlteris 1998)

**Spears**

A pole or shaft with a point on it can be used as a spear and a fisherman operating from shore, floating raft, and boat would be able to capture an animal previously out-of-reach. However, the single prong spear required an accurate aim, and fish easily escaped. With the addition of a barb, fish retention was improved; and spears with multi-prong heads increased the likelihood of hitting the target. Spears were initially hand-held, then thrown, then placed in launching devices including cross-bows, spear guns for divers, etc. Spears with long shafts (gig) are used by fishermen in small boats at night in the Carolina
sounds for flounder, through the ice for eels in New England bays, and by divers for fish in coastal waters. (DeAlteris 1998)

**Stop Seines**

Seines that are used in coastal embayments to "shut off" schools of fish such as herring, once they enter the embayment.

**Trammel Nets**

A trammel net consists of three layers of netting all attached to the same framing ropes, consisting of a float line and a lead line. The net is formed by placing a very loose small mesh sheet of netting between two large mesh sheets. Upon striking the net, fish push a pocket of small mesh through a large mesh and are trapped. Trammel nets may be used as drift nets or set nets at virtually any depth. (Sainsbury 1996)

**Paired Bottom Trawl**

Pair trawling is undertaken by two vessels towing a single net either on the bottom or midwater. The separation of the towing vessels is used to open the net mouth horizontally. Pair bottom trawls have been used to harvest groundfish in New England waters, and these trawls are generally no larger than the net towed by the vessel singly. The advantage of pair bottom trawling is that considerably more ground gear may be used so as to increase the area swept, due to the reduction in drag resulting from the absence of trawl doors. (DeAlteris 1998)

**Paired Midwater Trawl**

Large pelagic species are also harvested with a huge pelagic pair trawl towed at high speed near the surface. The nets have meshes exceeding 10 m in length in the jibs and first belly sections, and reduce to cod-end mesh sizes of 20 cm. (DeAlteris 1998)

**Weirs**

In Maine, Nova Scotia, and Alaska, large traps constructed of stakes set so close to each other, that they form a fence are referred to as weirs. The target species are migrating small pelagic fishers including herring and sardines. Sometimes the design is asymmetric so as to only capture fish migrating in one direction. (DeAlteris 1998)

### 4.6 IMPACTS OF FISHING-RELATED MARINE DEBRIS AND LOST GEAR ON HABITAT

When considering the potential adverse impacts of fishing activities on habitat, the attentions of most researchers and policy-makers are focused on active fishing, i.e., what are the effects on the seabed from mobile gear. Habitat, however, may be adversely affected by other fishing-related activities. Fishing gear has the potential to cause adverse impacts to habitat not only when being actively fished, but also if the gear...
becomes lost or broken accidentally or intentionally disposed of at sea. Storm activity is unavoidable and a leading cause of lost or broken gear, but fishermen may also contribute to the adverse impacts to habitat by disposing of non-biodegradable waste products at sea (cups, bags, casings, packaging materials, bait boxes, gloves, light sticks, etc.) (Cottingham 1988; EPA 1994).

Marine debris is usually defined as any man-made solid object that is introduced into the marine environment and is not actively utilized (Hoagland and Kite-Powell 1997). Debris can be found on the surface, in the water column, and on the seafloor, as well as along the coastline (Hoagland and Kite-Powell 1997). Marine debris can come from a variety of sources, including:

- municipal treatment systems
- recreational boating
- beach users
- commercial fishing
- oil and gas operations
- cargo vessels

In fact, studies done in New England report that the principal sources of marine debris in the region are from household trash, lobster pots, and monofilament gillnets (Anon. 1988). As much as eighty-five percent of the debris collected during beach cleanups in New England over the past ten years is attributed to shore-based sources (Hoagland and Kite-Powell 1997). In the Gulf of Maine, commercial fishermen are thought to account for approximately half of the remainder (Hoagland and Kite-Powell 1997). Data from the Center for Marine Conservation (various years) attribute approximately five percent of the marine debris in Massachusetts and five to ten percent of the marine debris in New Hampshire and Maine to commercial fishing vessels. These data may not accurately reflect the amount of debris from fishing related sources. The volunteers who conduct the beach clean-ups are not necessarily trained to identify all fishing-related marine debris and may mis-identify fishing-related debris as non-fishing-related debris. The true percentage of marine debris in New England that comes from fishing-related sources may be higher than previously reported (Howe, p.c.1998; Barr, p.c. 1998). Only in the northern northwest Pacific is commercial fishing identified as the primary source of marine debris (Anon. 1988). Along the northwest Atlantic coast, the most serious effects of marine debris are aesthetic and economic in nature (Heneman 1990). As debris mounts, beaches and harbors become defiled and the tourism industry risks losing its base of support.

The issue of marine debris and lost, or “ghost,” gear has recently gained more attention for its impacts on marine mammals, birds, and fish populations. New developments in uses for plastic materials have increased the amount and variety of plastics that find their way into the ocean. In fact, plastics now account for more than half of all marine debris in the Gulf of Maine, the rest being approximately equal proportions of metal, glass, and paper (Hoagland and Kite-Powell 1997). Marine mammals, birds, sea turtles, and fish are all known to become entangled in plastic debris and, in many cases, die as a result. Commercial fishermen also know these materials to be a nuisance, especially when they lose time and money making repairs when their propellers and propeller shafts become entangled. Fishermen also lose time and money replacing gear lost or broken as a result.
of storms or gear conflicts with other fishermen.

Fishermen are also known to bring in much of the gear that they accidentally tow up or observe floating in the ocean (Howe, pers. comm. 1998). These fishermen return the lost gear to shore and dispose of it; however, more and more fishermen are having problems properly disposing the gear, as landfills are filling up and traditional disposal sites are refusing to accept this debris (Howe, p.c.1998; Barr, p.c. 1998).

“Ghost” fishing has been defined as “the ability of fishing gear to continue fishing after all control of that gear is lost by the fisherman” (Smolowitz 1978). Lost gear includes ghost gear as well as gear that is lost to the fisherman but does not continue to fish. For the purposes of addressing the habitat impacts of gear that is lost to the fisherman, we will not differentiate between ghost gear and lost gear. Rather, we will use the term lost gear as more inclusive. One potential problem associated with lost fishing gear and habitat impacts involves the increasing proportion of gears constructed of non-degradable materials (Breen 1990). Unlike gear made from natural materials that deteriorate quickly, gear made from stainless steel, injection-molded plastic, fiberglass, vinyl-coated wire, polypropylene twine, or monofilament line persist in the environment for long periods of time (Breen 1990).

As concentrations of commercial fish species become harder to find, fishermen are seeking out new areas, fishing where the risk of gear hang-ups, tears, or loss is increased. Much of the lost gear is concentrated on the most productive fishing grounds (Carr and Harris 1997). Most assessments of the effects of fishing-related marine debris, including lost gear, focus on aesthetic and economic losses and the direct effects to the lives and health of fish, mammals, sea turtles, and birds (see Laist 1997 for review). No studies have been completed which address the effects of these materials on the habitat and very few data are available on marine debris on the seafloor (Hoagland and Kite-Powell 1997). An examination of the known effects on wildlife and fish, however, can provide some indication of the habitat impacts caused by marine debris.

Several studies were examined to determine if there are any known adverse impacts resulting from lost fishing gear on the seafloor (Breen 1990; Carr 1988; Carr and Harris 1997; Carr et al. 1992; Cooper et al. 1988; Laist 1997). All studies focused on the effects of the lost gear on fish populations due to the ability of certain gear types (primarily traps and gillnets) to continue fishing after becoming lost to the fishery (Breen 1990; Carr 1988; Carr and Harris 1997; Carr et al. 1992; Cooper et al. 1988; Laist 1997). The only times this lost gear was mentioned in reference to habitat or ecosystem-level processes was to suggest that the lost gear provided additional habitat for many species. According to Carr and Harris (1997), lost trawl nets have a low ghost-fishing potential, and the lost trawl net material may form additional habitat for certain demersal species, such as ocean pout, wolffish, and cod. Carr and Harris (1997) also suggest that the net material may serve as a substrate for sessile invertebrates, such as hydrozoans and sea anemones.

Cooper et al. (1988) used a submersible ROV to assess ghost fishing effects, and they observed three general types of associations between the animals and the gear: (1)
entanglement in the gear; (2) taking shelter within the interstices of the net; and, (3) attaching to the net. Several species of fish were documented using the net as shelter, including the sea raven, sculpin, and wolffish (Cooper et al. 1988). Stalked ascidians and sponges were observed attached to and growing on the net float lines (Cooper et al. 1988). Carr et al. (1992) also found sessile invertebrates using lost gillnets as substrate. They observed colonial bryozoans established on the monofilament webbing of an experimental gillnet only 72 days after the gear was set (Carr et al. 1992). The rapid colonization by sessile invertebrates on derelict fishing gear, transforming the gear into an inadvertent artificial reef, could be considered a beneficial effect of a situation that is otherwise considered problematic. Cod, in particular, appear to utilize lost gear as shelter. Carr (1988) observed cod, pollock, sculpin, redfish, and wolffish all in association with a derelict gillnet under study. Cod were the most abundant fish, observed each day of the survey and always within ten feet of the net, but never entangled in the net (Carr 1988). Carr (1988) states that "cod reacted to the net as if it was part of the bottom."

There is some debate on the issue of lobster and crab pots and traps. Pecci et al. (1978) reported significant ghost fishing of American lobster, Homarus americanus, and high levels of attendant mortality associated with field studies near Boothbay Harbor, Maine, and Woods Hole, Massachusetts. More recently, Parrish and Kazama (1992) report no evidence that lost traps result in increased mortality for Hawaiian spiny lobster, Panulirus marginatus, and slipper lobster, Scyllarides squammosus. It is difficult to make a direct comparison between these two studies, however, as they not only sampled different species, but also used very different trap designs and materials. It is significant to note that, using a more modern trap design, Parrish and Kazama (1992) were able to conclude that "such traps, when unbaited and intact, may best be considered short-term artificial shelters that lobsters enter and exit occasionally, more or less at will." The design of the lobster pot now used in the New England region includes a ghost panel as required by 50 CFR part 649.21(d), and may in fact operate as temporary artificial habitat allowing lobsters and fish free entrance and egress and reducing the potential impact of ghost gear on both the resource and the habitat.

Based on the limited literature focused on the interactions between lost gear and fish habitat, from the research that has been done, it appears that lost fishing gear does not pose a significant threat to essential fish habitat in New England. Marine debris is an issue that bears continued attention due to the limited information and studies focused on the habitat-related impacts of lost gear, as well as the potential impacts to marine life and the aesthetics and economics of shore-based communities. Technological advances and changes to gear design and materials should be monitored for potential impacts to habitat should the gear become broken or lost. For instance, as a result of measures to protect right whales in the Gulf of Maine, lobstermen are now required to switch from floating line (which rises to the surface if it becomes disassociated from the lobster pots) to lead line (which will remain on the seafloor and be harder to retrieve).

There are many good programs assessing the larger issue of marine debris as well as developing mitigation measures. The Center for Marine Conservation has the most
comprehensive program, supporting its annual beach cleanup activities with research, conferences, and educational programs. For a review of the habitat-related impacts resulting from non-fishing activities, please refer to Section 5.0 of this amendment. For a complete review the sources of and problems associated with marine debris in the Gulf of Maine, as well as a discussion of mitigation techniques, please see Characterization and Mitigation of Marine Debris in the Gulf of Maine, by Porter Hoagland and Hauke L. Kite-Powell (1997) for the Gulf of Maine Council on the Marine Environment.

4.7 IMPACTS OF AQUACULTURE IN NEW ENGLAND ON HABITAT

The farming of aquatic and marine finfish, shellfish, and plants has been practiced for thousands of years to provide a variety of resources (NRC 1992). Aquaculture is defined as any activity that manipulates reproduction, spawning, feeding, settlement, growth, and development of marine or freshwater organisms (e.g. the controlled cultivation and harvest of aquatic animals and plants) (USDA National Aquaculture Development Plan 1983; deFur and Rader 1995). The culture industry (i.e. aquaculture) is rapidly expanding because of increased understanding of the life requirements of reared species and the depletion of natural stocks. Research on the development and requirements of aquatic organisms has led to efficient farming practices that yield a substantial amount of resources. The decreasing catches of the commercial fishing industry has triggered increased attention on other methodologies to obtain marketable finfish, shellfish, and seaweed. Both the demand for fish and its price relative to other protein sources has led to an increasingly thorough investigation of culturing finfish and shellfish (Rosenthal 1994). The National Aquaculture Act of 1980 encourages the development of aquaculture in the United States. Effective management and strategic planning may increase productivity of the culture fishery industry and potentially reduce the pressure of the capture fishery on wild populations and habitats.

World aquaculture production has doubled since 1984 and represented 18.5% of the total world seafood supply, according to 1995 data (FAO 1997). China and India are the world leaders of aquaculture production (FAO 1997). China, Japan, Thailand, Philippines, Chile, and Norway have made aquaculture a national priority (USDA 1998). The declining populations of wild fish stocks, increasing demand for seafood, and government promotion of aquaculture is leading to the growth of aquaculture in the U.S. However, aquaculture development in the U.S. has occurred slower than in other countries (Fridley 1995). U.S. aquaculture has expanded steadily since the 1980’s and is poised to be a major growth industry in the 21st century (USDA 1998).

Freshwater culture, dominated by large catfish and trout farms, is more advanced than marine culture (i.e. mariculture) in the U.S. Marine mollusk rearing constitutes 95% of the U.S. marine culture production, and 80% of the production is oyster culture (Fridley 1995). Oyster culture appears to be declining due to pollution, disease, overharvesting, habitat loss, reduced production, and lack of seedlings in coastal waters (Volk 1998), but the culture of other mollusks (i.e. clams, scallops, and mussels) appear to be expanding (Fridley 1995). Salmon is virtually the only finfish commercially reared in marine waters of the U.S. However, there are several water-based demonstration projects for flounders and other salmonids. Important farmed species in the U.S. include catfish, oysters,
crawfish, trout, salmon, clams, baitfish, tilapia, hybrid striped bass, shrimp, mussels, and sturgeon (FAO 1997). Emerging aquaculture projects in the U.S. have the opportunity to address the environmental, institutional, and economic constraints associated with aquaculture to assist with minimizing the problems of production and environmental impacts and the set of new options in siting and culturing (Fridley 1995).

The majority of New England aquaculture occurs along the coast and in state waters. There are many successful salmon farms within Maine state waters (i.e. 500 net-pens) (Panchang et al. 1997). Currently, culture locations are being investigated throughout New England state and federal waters. The development of New England aquaculture into a sustainable industry has great promise given appropriate technical planning and development, including the insight of environmental issues, proper siting, and efficient monitoring (see Spatz et al. 1995 for review of New England aquaculture). The array of factors influencing the market for fresh seafood such as decreasing wild fishery stocks and increasing demand for seafood may stimulate large-scale aquaculture development. Tasks dealing with possible clean-up costs after the facility closes and by-product threats that may add to larger environmental problems (e.g. eutrophication and groundwater contamination) (deFur and Rader 1995) may inhibit the development of New England aquaculture. Despite the potential problems, the culture fishery in New England federal waters appears to be developing with several current and potential farm sites (Table 8).

Table 8: Current and proposed aquaculture sites and descriptions in the New England federal waters.

<table>
<thead>
<tr>
<th>NAME</th>
<th>LOCATION</th>
<th>TYPE</th>
<th>REARED ORGANISMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seastead Site (Westport)</td>
<td>south of Martha’s Vineyard</td>
<td>bottom</td>
<td>sea scallops</td>
</tr>
<tr>
<td>Sea Scallop Cage Growout Project</td>
<td>off of Gloucester, Cape Ann, MA, Stellwagen and Jeffreys Ledge</td>
<td>bottom cage</td>
<td>sea scallops</td>
</tr>
<tr>
<td>Proposed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American-Norwegian. Fish Farms, Inc</td>
<td>Gulf of Maine</td>
<td>net-pens</td>
<td>finfish</td>
</tr>
<tr>
<td>Univ. of New Hampshire demonstration project</td>
<td>Isle of Shoals (state waters)</td>
<td>net-pens</td>
<td>summer flounder</td>
</tr>
<tr>
<td>WHOI Blue Mussel Project</td>
<td>Rhode Island Sound</td>
<td>submerged longline</td>
<td>blue mussels</td>
</tr>
</tbody>
</table>

4.7.1 Aquaculture Types and Characteristics

Aquaculture systems can be separated into two categories; (1) land-based and (2) water-based. Land-based aquaculture systems include ponds, tanks, raceways, flow-through, and recirculating systems and are used throughout New England for the cultivation of a variety of marine and aquatic organisms. Land-based aquaculture is used for pilot studies, commercial production, and stocking programs. Water-based aquaculture methods include ocean ranching, cages / net-pens, longline culture, and bottom culture (infauna and epifauna) (reviewed in Goldburg and Triplett 1997). Water-based aquaculture is used to grow a variety of marine and anadromous finfish, shellfish, and seaweed to develop effective culture techniques and for commercial harvest.
Land-Based Aquaculture

(1) Ponds are the most widely used system in the U.S. (majority are found in the southeast) used to raise both finfish and shellfish in fresh or brackish water. They are constructed outdoors and vary in size. Impoundments (diked wetlands and marshes or excavated coastal environments) can be considered a form of pond system. Ponds account for approximately 75% of world production of finfish by aquaculture and almost all shellfish production (dominated by shrimp) (Royce 1996). Catfish, carp, baitfish, tilapia, and shrimp are a few of the major organisms cultured in ponds.

(2) Tanks are similar to ponds but are constructed of concrete, fiberglass, or treated wood (MCZM 1995). They are used to rear both marine and freshwater finfish and shellfish species. They vary greatly in size (e.g. pilot studies to commercial production), are usually circular or oval, and are constructed indoors and outdoors. They can operate as a flow-through or recirculating system. Tanks are used as hatchery and grow-out culture and brood stock management.

  a) Flow-through filtration systems are used for land-based facilities. They are characterized as open systems that do not re-use water. They are used as hatcheries and grow-out facilities and containment of brood stock of a variety of organisms. Clean water is pumped in and out of the holding containers to maintain good water quality.

  b) Recirculating filtration systems are used for land-based facilities. They are characterized as closed systems that the water is treated and re-used (50-90%) within the system. They are used as hatcheries and grow-out facilities for a variety of finfish and shellfish. Very few large-scale recirculating systems are operating in the U.S. Mollusks may be purified in recirculating systems. Hybrid striped bass, tilapia, trout, and others are cultured in recirculating systems.

(3) Raceways (generally freshwater) are usually a series of long, narrow, rectangular tanks with continuously flowing water. They are also constructed in other shapes and sizes. Raceways are located either inside or outside and are used primarily for salmonid culture. They operate primarily as a flow-through system but can also run as a recirculating system. Catfish, tilapia, and yellow perch are also raised in raceways.

Water-Based Aquaculture

(1) Ocean ranching is a culture process that involves hatching fish from eggs and rearing to juvenile stages in freshwater captivity (land-based) then releasing fish into native feeding grounds in the sea. Fish develop and sexually mature in the natural environment and return to their home stream (the land-based hatcheries) to spawn and are harvested along their migratory route (Royce 1996). This aquaculture procedure has been used with salmon.

(2) Cages, net-pens, rafts, and trays are either floating, anchored to the bottom, or a
combination of both within a natural body of water. Cages / net-pens are currently found close to shore and are used to rear finfish (e.g. salmon) and mollusks (e.g. sea scallops). Finfish culture usually involves anchored pens floating in open water. Cages or trays anchored to the seafloor adjacent to suitable environmental conditions are used for mollusk grow-out. Rafts or floats may also be used to culture seaweeds.

(3) Longline culture (or hanging culture) is used for shellfish (i.e. mollusk) growout. Shellfish are grown in bags attached to a line either suspended in the water column or on the water surface. Longlines have been used vertically and horizontally. Lines must be placed in regions with proper water quality. The longlines are usually easily moved to find suitable environmental conditions for fastest growth. Mussels are potential organisms reared with this method. Seaweed can also be cultivated using longlines.

(4) Bottom culture is used for mollusks. Infaunal bottom culture occurs within the benthos. Hard clams are seeded and reared this way. Epifaunal bottom culture involves rearing techniques on the surface of the seafloor. Bottom culture depends on a sufficient food supply and water quality provided by tidal circulation and currents. This method applies to any seeding project (i.e. resettled or juvenile organisms transplanted to growing enclosures or proper substrate).

4.7.2 Environmental Considerations

The progress of the culture fishery may be inhibited by potential aquaculture-induced threats impacting habitat. The intensity and magnitude of impacts to habitat differ between the types of aquaculture systems and organisms cultivated (Table 9). Land-based facilities appear to be less intrusive and have fewer potential direct impacts to aquatic and marine habitats than water-based systems. Land-based aquaculture facilities require discharge permits [i.e. National Pollution Discharge Elimination Systems (NPDES)] (see Ewart et al. 1995); however, land-based culture is still a potential source of contaminants and physical disturbances that could contribute to the degradation of coastal environments. Systems constructed and maintained directly within marine and aquatic environments (water-based facilities) may pose serious threats to the health and natural productivity of habitat. The potential environmental problems of land- and water-based facilities have separate impacts to habitat, yet all aquaculture types have potential impacts on habitat and concern has been voiced on the particular characteristics of these impacts.

Numerous differences exist between cultivation of shellfish and rearing finfish in the wild. Several studies have illustrated the possible problems with finfish farms (Bedzinger 1994; Findlay et al. 1995) and potential problems associated with shellfish cultivation (Grant et al. 1995; Herke 1995; Thompson 1995; MCZM 1995). A major discrepancy between finfish and shellfish (mostly mollusk culture in New England) culture is the foraging behavior of the different taxa. Finfish require a large amount of feed, which has several environmental implications. Mollusks are filter feeders and generally require no feed additives. Shellfish bottom culture also appears to be less intrusive than fish pens by simply manipulating natural conditions, making the
environment more suitable for faster growth and higher survivorship of the cultivated organism. Noting that large-scale aquaculture in the wild may increase the productivity of a few selected species, but the overall ecosystem productivity and health may be diminished (Herke 1995).

The environment can also be used with relatively minor impacts for the rearing of finfish by properly locating and carefully operating and monitoring fish pens to reduce possible habitat problems. The impacts (e.g. waste, direct benthic disturbance, etc.) of properly sited net-pens appear to be limited to the area directly beneath the pens in habitats with slower currents and softer sediments. Habitats associated with stronger currents and coarse sediments appear to have more widely distributed but less intense impacts due to spreading and diluting the contaminants over a large area (see review Conkling and Hayden 1997). Suspended shellfish culture may have similar impacts as net-pens (Conkling and Hayden 1997), and the impacts may be diminished using the same siting criteria. However, stating several options that may reduce the potential impacts of aquaculture on habitat and the generic differences between types of aquaculture and species cultivated, discharge (e.g. effluent and metabolic waste) may contaminate water quality and benthos, natural ecosystems may be altered, and direct loss of habitat may occur with the development of aquaculture.

**Discharge**

Aquaculture discharge into the water column, either land- or water-based, may include metabolic wastes (e.g. feces and pseudofeces), nutrients, ammonia, particulate matter, pesticides, and drugs (*discussed under feed additives*). The variety of threats within aquaculture effluent or waste presents potential impacts to the water column, benthos, and associated biological associations. Water quality can be adversely impacted by these threats (Hopkins *et al.* 1995) and degrade overall habitat conditions. Discharges may also include excess food and shell debris in addition to the previously mentioned threats, and may also specifically contribute to degradation of benthic habitat surrounding the aquaculture site (Findlay *et al.* 1995; Panchang *et al.* 1997). Discharge and waste may disrupt and change benthic structure and biological associations (Rosenthal 1994; Findlay *et al.* 1995; Grant *et al.* 1995;).

Discharge may contribute to nutrient over-enrichment, leading to organic loading and eutrophic conditions in the water column and benthos. Eutrophication has been associated with serious harmful algal blooms (HABs), finfish and shellfish kills, and habitat degradation. The benthos may accumulate wastes discharged from aquaculture facilities and contribute to anoxic conditions in the bottom sediments and overlaying water (deFur and Rader 1995) characterized by bacterial mats growing on the bottom sediments below aquaculture sites (Rosenthal 1994). Areas adjacent to aquaculture facilities may also exhibit increased sedimentation rates (Grant *et al.* 1995). Nutrient enrichment and sedimentation can also contribute to the degradation of submerged aquatic vegetation that provides important habitat for a variety of marine and aquatic organisms (Goldsborough 1997). The additional nutrients and metabolic wastes from aquaculture facilities may disrupt nutrient cycling between the benthos and water column (Kelly 1992) and potentially promote hypernutrification and oxygen depletion (Rosenthal
Poor benthic habitat conditions may change, disrupt, or destroy benthic communities and may present a future source of contamination if disturbed (i.e. channel dredging). Additional nutrients and wastes entering the environment or alterations to existing nutrient cycles potentially have long-term impacts on both chemical, biological, and physical characteristics of habitat (Kelly 1992).

Although not used by all aquaculture facilities, pesticides are frequently used to control a variety of nuisance organisms within aquaculture sites and can be present in effluents. Algicides, herbicides, and fungicides are pesticides that can be used to control aquaculture water quality and organism health. Pesticides may hinder growth or directly destroy aquatic vegetation and phytoplankton and lower dissolved oxygen levels (Stickney 1994). Alteration of aquatic vegetation potentially limits the availability of important habitat (Goldsborough 1997), and the removal of phytoplankton may have cascade effects on wild resources. Antibiotics can also be added to the water to control diseases in cultured organisms (discussed under feed additives). Public concerns about human food safety, human health, and environmental impacts have resulted in strict interpretation and enforcement of U.S. Food and Drug Administration (FDA) on the use of chemicals to treat water in aquaculture facilities (MCZM 1995).

### Feed Additives: Antibiotics and Hormones

Feed additives are part of the maintenance of reared organisms in many water- and land-based aquaculture operations. The occurrence of diseases in aquaculture facilities is frequently due in part to the high densities of organisms (see USFWS 1995). Antibiotics and hormones are added to feed in order to supplement and enhance the diet of the reared species to control disease, induce spawning, produce strains of organisms resistant to disease, produce high quantities of meat, grow faster, and alter a variety of phenotypic characteristics. Feed supplements may be toxic to nontarget organisms, accumulate in wild stocks, inhibit microbial decomposition, and lead to antibiotic-resistant pathogens (Conkling and Hayden 1997).

The high densities of organisms within an aquaculture system may lead to high levels of feed additives in the water and benthos. Antibiotics and hormones added to the environment for aquaculture uses can potentially disrupt habitat. Antibiotics may produce drug-resistant strains of pathogens that can spread disease among marine and anadromous organisms (Landesman 1994). New strains of pathogens can have sublethal or lethal impacts on fish and invertebrates and possibly degrade overall habitat conditions. The accumulation of antibiotics within the benthos may inhibit microbial decomposition (NRC 1992). Accumulation of antibiotics and hormones in both wild and cultivated organisms is a potential health risk for human consumers. Feed supplemented with hormones potentially changes natural growth and spawning behaviors of finfish and shellfish populations. Changes in natural behavior, development, and growth patterns (Goldburg and Triplett 1997) can lead to niche competition and overlap (Lura and Seagrov 1991; Jonsson et al. 1991).

These potential impacts of feed additives may contribute to habitat degradation, yet only four drugs are approved for the use on reared organisms in the U.S. The U.S. appeared to
take cautious approach with the addition of diet supplements to reared organisms that potentially risk human health until recently. The Animal Medicinal Drug Use Act of 1994 and implementing regulations promulgated by the Food and Drug Administration has led the U.S. to become considerably less cautious with the use of drugs in aquaculture operations (Goldburg pers. com.).

Exotic and Reared Species

Introduction of non-native organisms have altered biological and physical composition of several freshwater and marine habitats (Rosecchi et al. 1993; Witman 1996). The issue of the introduction of exotic or reared species, including finfish, shellfish, plants, and parasites, in the wild is a major concern and possibly the largest problem for aquaculturists, ecologists, and managers (deFur and Rader 1995). Reared and exotic organisms have been released from aquaculture facilities accidentally (e.g. escapees) and intentionally (e.g. stocking programs) (Bedzinger 1994). The natural community structure may be changed through increased competition, niche overlap, predation on indigenous organisms, decreased genetic integrity, and transmission of disease. The impacts of released or escaped organisms are the focus of much attention. Several methods, including producing sterile organisms and escape-proof facilities, are being developed to lessen the ecological threats associated with exotic and reared organisms (Conkling and Hayden 1997; MCZM 1995).

The United States Fish and Wildlife Service (USFWS) has determined that salmon aquaculture poses a notable threat to the wild stocks of Atlantic salmon (Salmo salar) (Conkling and Hayden 1997). Farmed salmon have been documented to spawn successfully and later in season than wild Atlantic salmon (Lura and Seagrov 1991; Jonsson et al. 1991) often taking over the breeding sites of the wild salmon (Bedzinger 1994) and limiting the success of the natural spawning process. Genetic problems may also occur with the release of reared organisms, either from escapees or stock enhancement projects, due to limited genetic drift in small broodstocks and interbreeding potential with wild stocks.

The selection of fish in a hatchery, illustrating their captive characteristics (appearance, size, and fast growth) and not their selective characteristics, are expected to become less fit for survival in the wild (USFWS 1995; Bedzinger 1994). The genetic diversity and phenotypic plasticity of natural populations may be diluted with the release or escape of cultured finfish (Fleming et al. 1994; Tave 1994). For example, there has been a growing concern that Atlantic salmon, that escape from farms may interact with wild stocks and pose a serious threat to the native populations, leading to changes in genetic composition, introducing diseases and parasites, and other possible negative impacts to habitat (USFWS 1995; Windsor 1997). Interactions between native and reared striped bass (Morone saxatilis) have also been noted (NRC 1992). The consequences of exotic and reared organisms is not limited to salmon aquaculture. Trophic structures, stock health and fitness declines, and overall habitat degradation may result from the release or escapement of any organism from aquaculture facilities.

The introduction of infectious diseases, particularly nonindigenous parasites, transmitted
to wild resources is a major issue facing aquaculture proponents. The impacts of pathogens on wild stocks are generally misunderstood or seriously underestimated (MCZM 1995). The transmission of disease from aquaculture facilities through effluent, stocking programs, or escapement is a potential issue that may impact the health of the stocks and environment. For example, salmonid populations have been infected with whirling disease (Myxobolus) from releasing disease-infected organisms in a stock enhancement project. This particular disease has had serious impacts of salmonid populations in Colorado, Utah, New York, and Connecticut (MCZM 1995).

**Habitat Removal or Alteration**

The development of aquaculture facilities, either land- or water-based, may directly remove or change the physical and biological properties of habitat (Rosenthal 1994; deFur and Rader 1995; Thompson 1995). Construction of facilities on the shoreline may directly remove important watershed habitat. Water withdrawal for land-based aquaculture may present entrainment and impingement problems (Hopkins et al. 1995). Large facilities require an abundant supply of water, and may disrupt habitat conditions in the area surrounding the intake and effluent pipes. Conflicting water-use issues may be an additional problem facing aquaculture development (*discussed below*).

Improperly placed water-based facilities may attract unnatural species assemblages or change existing biological communities (Thompson 1995). Specifically, bottom culture of shellfish directly alters the benthos in order to improve habitat conditions for survival, growth, seeding, and harvesting (Ito 1988; Anonymous 1990; Thompson 1995; Conkling and Hayden 1997). Other organisms dependent on these habitats may suffer because of the loss or manipulation of habitat to construct aquaculture systems (Landesman 1994; Rosenthal 1994). The loss and change of habitat and natural community structure is a potential adverse effect of land- and water-based aquaculture on habitat.

High densities of shellfish or finfish within water-based operations may remove a large quantity of indigenous organisms (Ulanowicz and Tuttle 1992) and essential nutrients from the environment (Kelly 1992). Large assemblages of filter feeders (e.g. mollusks) and larval fish in cages or pens may feed on unusually high amounts of plankton. The removal of plankton from an ecosystem may have cascade effects on the trophic structure. Increasing mollusk concentrations may decrease phytoplankton productivity as well as pelagic populations of microbes, ctenophores, medusae, and particulate organic carbon (Ulanowicz and Tuttle 1992). Filtering unusual amounts of nutrients from the water column and benthos may alter the nutrient cycle. Long-term implications to the environment may result with large-scale aquaculture projects.

**Other Considerations**

- Predator control devices and techniques around aquaculture facilities may *eliminate organisms* from the wild, presenting trophic implications (Rosenthal 1994). Birds potentially disrupt aquaculture facilities by foraging on reared organisms. Killing the predator may have cascade effects on trophic dynamics. Concern has been voiced over the authorization to kill predators at aquaculture facilities (Goldburg and Triplett...
1997). Also, marine mammal, birds, and reptiles can be trapped in aquaculture nets (MCZM 1995), although entanglement is rare (Conkling and Hayden 1997).

- **Capturing wild species** for the purpose of stocking aquaculture facilities is a potential problem contributing to declining stock size and habitat degradation (Landesman 1994). All facilities need organisms to begin and maintain production. Brood stock are often collected from the wild to provide a source of organisms for the facility. Extensive collections may add to the current problem of overfishing and may degrade habitat.

- **User conflicts** may evolve with the development of land- and water-based aquaculture. User groups may compete for existing habitat for their specific interests, potentially contributing to habitat removal or degradation. Particularly, water-based aquaculture practices may inhibit other activities (e.g. commercial fishing and navigation). Land-based facilities also face potential water-use conflicts, especially with terrestrial agriculture. Therefore, the siting of aquaculture facilities may be an issue of controversy for a variety of interest groups.

### 4.7.3 Environmental Benefits

Rosenthal (1994), referring to salmon aquaculture in Europe, stated that the negative effects of aquaculture on the environment have not been as severe as the scientists anticipated, the media reported, or the public perceived. Some cases have actually demonstrated the importance of aquaculture in maintaining productive habitats and possibly contributing to a healthier environment. These examples of aquaculture development appear to positively influence habitat. Proper siting and monitoring measures can lessen the potential threats that aquaculture pose to habitat. Water-based cultivation (e.g. net-pens) and land-based facilities (e.g. ponds) can be constructed that abate potential impacts to habitat.

The health and success of organisms in the wild and aquaculture facilities depend on good water quality. Studies have illustrated the importance of aquaculture contributing to good water quality (Ulanowicz and Tuttle 1992) and the importance of water quality on aquaculture (Volk 1998). The filtering capacity of mollusks may eliminate unwanted nutrients and contaminants from the water column (Ulanowicz and Tuttle 1992). Culture facilities that depend entirely on natural trophic dynamics and receive important nutrients from agricultural run-off may assist in reducing the threats of land-based pollutants (Rosenthal 1994). Culturing mollusks at an appropriate density in coastal areas may contribute to improving water quality, lessening eutrophication, and enriching habitat conditions for natural stocks.

Shell debris from mollusk cultivation may provide a suitable substrate for benthic communities. Shells may provide some level of protection and refuge for fish and invertebrates under and within cultivation areas, improving habitat conditions.

Productive culture facilities may reduce pressure on natural fish and shellfish stocks, but should not be viewed as a method to sustain fish stocks. The culture industry may effectively provide a source of finfish and shellfish to consumers world-wide. A source
of seafood besides the traditional commercial fishery (capture fishery) may lessen the amount of fishing effort on natural finfish and shellfish populations. Reduced effort on natural populations may indirectly provide habitat and fish stock protection.

Table 9: Aquaculture type and impact to habitat.

<table>
<thead>
<tr>
<th>AQUACULTURE TYPE</th>
<th>POTENTIAL IMPACTS TO HABITAT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land-Based</strong></td>
<td></td>
</tr>
<tr>
<td>Ponds</td>
<td>• run-off and discharge may add metabolic wastes, nutrients, particulate matter, antibiotics, and hormones to water column and benthos</td>
</tr>
<tr>
<td></td>
<td>• seepage of contaminated water into groundwater</td>
</tr>
<tr>
<td></td>
<td>• potential source of reared organisms entering the environment</td>
</tr>
<tr>
<td></td>
<td>• direct destruction of habitat and biological properties for construction</td>
</tr>
<tr>
<td></td>
<td>- construction of impoundments in coastal waters alters important habitat for estuarine-dependent organisms</td>
</tr>
<tr>
<td>Flow-Through Tank and Raceway Systems</td>
<td>• discharge may contribute levels of metabolic wastes, nutrients, particulate matter, antibiotics, and hormones to water column and benthos</td>
</tr>
<tr>
<td></td>
<td>• water use may present withdrawal issues (e.g. entrainment and impingement)</td>
</tr>
<tr>
<td>Recirculating Tank and Raceway Systems</td>
<td>• limited discharge may contribute minor levels of metabolic wastes, nutrients, particulate matter, antibiotics, and hormones to water column and benthos</td>
</tr>
<tr>
<td></td>
<td>• water withdrawal for operation may present impacts associated with entrainment and impingement</td>
</tr>
<tr>
<td><strong>Water-Based</strong></td>
<td></td>
</tr>
<tr>
<td>Ocean Ranching</td>
<td>• interbreeding with wild stocks may cause genetic problems and natural behavior changes (e.g. unnatural foraging behavior)</td>
</tr>
<tr>
<td></td>
<td>• disease transmission from hatchery and grow-out facility into environment</td>
</tr>
<tr>
<td>Cages / Pens</td>
<td>• by-products – including metabolic wastes, nutrients, particulate matter, excess food, and shell debris – may contaminate water quality and benthos</td>
</tr>
<tr>
<td></td>
<td>• feed additives – antibiotics and hormones – may contribute to diseases and community structure changes</td>
</tr>
<tr>
<td></td>
<td>• introduction of exotics or reared organisms via escapement can lead to trophic structure changes, genetic and disease problems</td>
</tr>
<tr>
<td></td>
<td>• removal of indigenous organisms may hinder natural processes</td>
</tr>
<tr>
<td></td>
<td>• bottom cages may attract unnatural species assemblages and remove substrate</td>
</tr>
<tr>
<td></td>
<td>• “ghost” gear (e.g. broken pens, lost nets, or damage due to violent storms) may present habitat problems due to settling and rolling on the seafloor</td>
</tr>
<tr>
<td>Longline</td>
<td>• poor water quality and accumulation of wastes in benthos from by-products – metabolic wastes, nutrients, particulate matter, excess food, and shell debris</td>
</tr>
<tr>
<td></td>
<td>• feed additives – antibiotics and hormones – may contribute to diseases and community structure changes</td>
</tr>
<tr>
<td></td>
<td>• removal of indigenous organisms (i.e. plankton) may hinder natural processes</td>
</tr>
<tr>
<td></td>
<td>• lines may attract unnatural species assemblages</td>
</tr>
<tr>
<td>Bottom Culture - infauna / epifauna</td>
<td>• poor water quality and accumulation of wastes in benthos from by-products – metabolic wastes, nutrients, particulate matter, excess food, and shell debris</td>
</tr>
<tr>
<td></td>
<td>• feed additives – antibiotics and hormones – may contribute to diseases and community structure changes</td>
</tr>
<tr>
<td></td>
<td>• introduction of reared organisms may increase competition and predation on naturally occurring species</td>
</tr>
<tr>
<td></td>
<td>• direct loss of habitat / loss of natural biological components of habitat</td>
</tr>
<tr>
<td></td>
<td>• attract unnatural species assemblages</td>
</tr>
</tbody>
</table>
4.7.4 Legal Authority

The Magnuson-Stevens Act's broad definition of "fishing" encompasses the catching or taking of fish, the harvesting of fish and any other activity or at-sea operations in support of such activity which may result in the catching, taking or harvesting of fish. As harvesting implies the gathering of a crop and as aquaculture facilities engage in the "harvest" of fish from the EEZ, any aquaculture facility located in the EEZ is thus within the purview of the Act and is subject to management plans developed by the Council. That aquaculture is considered to be equivalent to fishing is further supported by the Vessel Documentation Act, 46 U.S.C. 12101(a)(1) which defines "fisheries" as including "planting, cultivating, catching, taking, or harvesting fish . . . in the EEZ."

Any vessel, including a barge, used to support aquaculture activities and facilities is considered a fishing vessel under Magnuson and is subject to regulation beyond documentation and endorsement at the discretion of the Council, subject to the approval of the Secretary of Commerce. In this context, it would appear that structures used to support and anchor net pens for finfish aquaculture would also be considered fishing vessels under the Magnuson-Stevens Act's broad definition which includes "other craft which is used for . . . aiding or assisting . . . any activity relating to fishing, including . . . storage . . . " 16 U.S.C. 1802(11).

4.7.5 Federal Involvement with EEZ-Based Aquaculture

No single federal agency has been delegated or statutorily charged with lead or overall responsibility to administer aquaculture, but rather, through authorities derived from various statutes, a number of agencies are involved. This situation is somewhat confused from the perspective of project developers who must complete an array of permit applications and meet a variety of requirement, some duplicative, in order to undertake an EEZ-based aquaculture operation. This section identifies those institutions and the basis of their derivative authority. This section also identifies other jurisdictions concerned with aquaculture that operate within or adjacent to the New England EEZ that may be applicable to the Council's activity.

U.S. Army Corps of Engineers

The ACOE authority stems from Section 10 of the River and Harbors Act of 1899, 33 U.S.C. 403. The Corps' traditional and primary role relates to the potential impact of activities upon the navigable waters of the U.S. and, with regard to aquaculture, is it particularly concerned with structures and the mooring systems used to anchor these structures within the navigable water. Its authority also extends to a full range of other considerations including those related to the environment and its permit certifies that the project will not impede navigation or negatively affect environmental quality.

U.S. Environmental Protection Agency

Section 402 of the Federal Water Pollution Control Act established the National Pollutant Discharge Elimination System (NPDES) to ensure that point source discharges would not
impair the nation's water quality. The EPA, which has statutory authority to administer NPDES permits, has determined that floating fish pens constitute "concentrated aquatic animal production facilities" under the Act and are thus subject to permit requirements. The agency has also determined that the Ocean Disposal Criteria of section 403(c) of the Act applies, thus mandating an environmental effects review of aquaculture projects proposed for offshore waters. Currently, the EPA requires an NPDES permit for fish pen operations only; shellfish or other "low impact" aquaculture operations are administratively exempt, however, a broad interpretation of the Act's "concentrated aquatic animal production facilities" language could be construed to apply to these operations as well.

National Oceanic and Atmospheric Administration (NOAA)

NOAA, through the National Oceans Service, administers the Coastal Zone Management Act (CZMA), 16 U.S.C. 1451 et seq., which requires a consistency determination with approved state coastal zone management programs for federally permitted activities that affect land, water, or natural resources of the coastal zone. Federal consistency reviews are conducted by the state coastal zone management programs, consistent with the CZMA. The Marine Protection, Research, and Sanctuaries Act which prohibits certain activities within areas designated as National Marine Sanctuaries and requires a permit (in the Stellwagen Bank National Marine Sanctuary) and consultation with NOAA's National Ocean Service in some instances.

National Marine Fisheries Service

The National Marine Fisheries Service has regulatory authority to enforce measures adopted pursuant to Council or Secretarial FMPs. The harvest of Atlantic salmon in the EEZ, for example, is currently prohibited under provisions of a Council FMP and the taking of other species is restricted in a variety of ways including minimum size restrictions and vessel permit requirements which are enforced and administered by NMFS. As aquaculture facilities are subject to the Magnuson-Stevens Act, NMFS does have direct regulatory control over aquaculture, albeit incidental to management plans for other fisheries at this time. In the absence of an aquaculture focused FMP, NMFS' principal role in aquaculture is with respect to its statutory authority to administer the Marine Mammal Protection Act, 16 U.S.C. 1361 et seq., its statutorily shared responsibility with the U.S. Fish and Wildlife Service to administer the Endangered Species Act, 16 U.S.C. 1531 et seq. and its prerogatives as a review agency under the Fish and Wildlife Coordination Act, the National Environmental Policy Act, and the Magnuson-Stevens Act.

U.S. Coast Guard

U.S. vessels, including barges, that support aquaculture facilities and that measure five net tons or larger must obtain Coast Guard documentation.
Other Federal Agency Involvement

Beyond the agencies and activities outlined above, there are several other federal agencies that may have involvement with EEZ-based aquaculture depending on the nature of the venture. These agencies include the U.S. Fish and Wildlife Service as a review agency addressing issues somewhat related to those that would be of concern to NMFS and the U.S. Food and Drug Administration if the use of medicated feeds is contemplated. It is also possible that the U.S. Department of State as well as the Minerals Management Service may have an interest in certain aspects of EEZ-based aquaculture activities. In addition, there is a growing list of federal agencies involved in aquaculture research and development activities which are beyond the scope of this review.

4.8 IMPACTS OF AT-SEA FISH PROCESSING ON HABITAT

Fish processing is an important component of fishing operations and economies of many New England fishing communities. Processing includes, but is not limited to, cleaning, cooking, canning, smoking, salting, drying, or freezing. Fish processing plants can be permanent, land-based or mobile, water-based operations. Commercial fisheries and aquaculture facilities require processing operations to produce high-quality, marketable seafood. There are several environmental considerations associated with all types of fish processing plants. Treatment of fish processing effluent to reduce environmental impacts has become a matter of interest to many countries and fisheries (Parin et al. 1983).

The type and severity of waste effluent from fish processing depends upon the type and characteristics of the processing operation. For example, processing limited to freezing whole fish may have less of an environmental impact than processing methods that require fish cooking (Battistoni and Fava 1994). The type of organism processed may also determine the severity of the potential threats. Battistoni et al. (1992) reviewed studies reporting higher concentrations of nutrients in effluents from salmon and herring processing operations than effluents from clam and oyster processing plants. Generic classification of fish processing approaches include:

- **Traditional Approach** which includes the establishment of permanent, shore-based, centralized facilities (Kneller et al. 1993); and

- **Mobile fish processing plants** which have developed with technological advancements in vessel capacity and size. This approach provides an at-sea, mobile infrastructure to support the capture fisheries and aquaculture facilities (Kneller et al. 1993) for quicker processing to yield higher quality products.

In New England, fish processing plants are primarily shore-based located within fishing ports and harbors. There are currently no at-sea fish processors operating in federal waters off New England, but several mobile processors operate in state waters. At-sea processing in state waters currently occurs in internal the waters of a state landward of the baseline used to delineate the inner boundary of the territorial sea (e.g. bays). Federal
waters can potentially be used for at-sea fish processing by joint venture operations. Joint ventures include any operation by a foreign vessel assisting fishing by U.S. fishing vessels, including processing. Joint venture generally entails a foreign vessel processing fish received from U.S. vessels. In New England, the federal size restrictions placed on vessels possibly limits the financial benefits of processing at sea.

The herring, menhaden, and mackerel fisheries present potential opportunities to use at-sea processors in New England waters. The development of water-based aquaculture (e.g. net pens, bottom culture, etc.) may also present greater financial opportunities for the advancement of at-sea processing operations for reared organisms (Kneller et al. 1993). Permanently located culture sites may develop at-sea processors to quickly supply high-quality, fresh seafood to consumers.

Techniques for land-based waste treatment are more advanced than at-sea treatment. Land-based treatment of waste includes physical and physicochemical separation biological treatments (Meo et al. 1977). Fish processing wastes can be disposed on land or in the ocean. The wastes present environmental concern, and raise questions on how to reduce the potential threats to habitat. Several methods to reduce or lessen environmental threats of processing effluents are denitrification to remove nutrients from effluent, fermentation to increase phosphorus removal, aeration (oxidation) techniques to increase dissolved oxygen levels in wastewater and lessen anoxic effluent, and hydrolysis of wastes to dilute threats (Battistoni and Fava 1995). These techniques potentially lessen impacts to habitat by producing stabilized waste, high quality effluent, and efficient settling velocity of wastes. The techniques rely on plant reliability to efficiently reduce potential habitat impacts (Battistoni and Fava 1995).

4.8.1 Environmental Considerations

Fish processing plants may present several environmental considerations, but the magnitude and severity of potential impacts may depend on the scale of operation. Small-scale processors, either at-sea or shore-based, may present less severe environmental impacts than large processors discharging large quantities of processing byproducts. The particular habitat conditions surrounding a given processing operation may also dictate the severity of impacts to habitat. At-sea or shore-based fish processing operations, in general, may present the following potential environmental threats (reviewed by Battistoni and Fava 1994):

- Water Exhaustion: Water is used for defrosting, cleaning, can cooling and can washing, clean up for spills, floors and machine washing. Large quantities of water are needed for processing fresh seafood (Nair 1990). Water use for land-based processing plants may contribute to the depletion of groundwater supply, saltwater encroachment, and land subsidence (Nair 1990) (see non-fishing threats section). At-sea processing raises less of concern of water depletion, but no less concern of wastewater discharged.

- Wastes: Chemical and biological wastes are produced from, but not limited to, fish evisceration, fish cooking or precooking, and meal production. The large
volume of water needed for processing thereby generates large amounts of wastewater effluent and associated habitat threats that potentially deteriorate environmental conditions (Nair 1990) (see *non-fishing threats section*). Wastes found in fish processing effluent include:

- nutrients (nitrogen and phosphorus) – that potentially contribute to eutrophic conditions,
- oil and fats (Parin *et al.* 1983) – that may alter water quality,
- organic matter – large pieces of discarded fish parts (i.e. viscera, bones, etc.) may provide food for birds, marine mammals, and subsurface scavengers (ICES 1991; Gislason 1994) and alter species composition due to competitive trophic interactions (e.g. seabirds) (ICES 1991),
- suspended solids consisting of fine grained fish parts (Nair 1990) – potentially increasing turbidity and attracting unnatural foraging species assemblages,
- fish discards potentially accumulate on the benthos posing a variety of short- and long-term effects on localized habitat (ICES 1991),
- stick water (a fine gel or slime) – can accumulate on surface waters or move onshore to cover intertidal areas (NPFMC 1998),
- mollusk shells – shells are often discarded at-sea and may provide substrate that serve a variety of ecological functions (e.g. settlement habitat for scallops; refuge for juvenile fishes),
- chemicals used during operation – may contaminate water quality (e.g. acidic water) and surrounding benthos,
- warm water plumes – may alter natural temperature regimes, and
- saltwater effluent – often used within processing plant. Salt water can not be discharged to treatment plants because they disrupt the biological cycles used to treat wastes, and can not be discharged directly back to the water because of discharge permit requirements.

### 4.8.2 Management Authority

Fish processors, either at-sea or shore-based, require National Pollutant Discharge Elimination System (NPDES) permits from the Environmental Protection Agency (EPA). The Ocean Dumping Act also requires any processing operation to obtain a permit from EPA to dispose any wastes. The Ocean Dumping Act gives authority to the EPA to regulate the contents of any disposed material, location, and methodology of disposal of fish wastes, including fish wastes from processing plants. These conditions of processing sites and dumping or discharge of byproducts would be developed by the EPA in consultation with the National Marine Fisheries Service and the fishing industry.
4.8.3 New England Fishery Management Council’s Role

The Council has the authority to address and regulate fish processing in federal waters administered under the Magnuson-Stevens Act. The Magnuson-Stevens Act includes at-sea fish processing under its definition of fishing, giving the Council direct authority to regulate all at-sea processing in the Exclusive Economic Zone (EEZ). Currently, the Council does not directly regulate at-sea fish processors in federal waters. At-sea processors may be indirectly regulated by other management measures directly pertinent to fishery regulations (e.g., size restrictions of vessels).

4.9 MITIGATION OF ADVERSE IMPACTS

The Council is required to prevent, mitigate, or minimize any adverse effect from fishing, to the extent practicable, if there is evidence that a fishing practice is having an identifiable adverse effect on EFH. Identifiable impacts are those supported by observable, negative effects on EFH quality or quantity. The previous sections discuss the issues and limitations associated with assessing adverse impacts to habitat from fishing activity, as well as the types of fishing gear and other fishing-related activities that may impact essential fish habitat. The Council also must give special consideration to gear types that will or could affect habitat areas of particular concern. Management measures currently in place protect and conserve essential fish habitat to varying degrees. Certain measures, such as the long-term closures of Closed Areas I and II and the Nantucket Lightship closure directly protect large areas encompassing many types of habitat. Other measures, such as the days-at-sea program, indirectly protect and conserve essential fish habitat by controlling fishing effort. Any reduction of fishing effort will reduce the frequency and intensity with which fishing gear is used.

4.10 IDENTIFICATION OF EXISTING MANAGEMENT MEASURES THAT AFFECT EFH

An understanding of the existing management measures that have the potential to either directly or indirectly protect EFH is important to the assessment of fishing-related threats to essential fish habitat (EFH). In order to determine which current management measures protect EFH, the Council performed an assessment of the habitat effects of all existing management measures.

For the purposes of this assessment, it is assumed that bottom-tending mobile fishing gears, such as dredges and trawls, are likely to have an impact on habitat. This assessment generally assumes some degree of adverse impact from bottom-tending mobile gear on most complex bottom types and is based on the available literature and scientific studies (see Appendix E for review), as well as anecdotal information provided by members of the fishing industry (see Dorsey and Pederson 1998). As more information becomes available on the effects of fishing practices on habitat and the relationships between species productivity and habitat, this assessment may change. Certain fixed gear types, such as lobster pots, gillnets, and longlines, are assumed for the purposes of this exercise to have minimal direct impact on habitat. As more information becomes available on the effects of these gear types, this assessment may change. Other
gear types, designed to be used above the sea floor, such as midwater trawls, purse seines, or pelagic longlines, are assumed for the purposes of this assessment to have no direct impact on habitat.

An important issue related to the cumulative effects of several of these measures involves effort displacement. Area closure and other effort restriction measures often simply have the effect of shifting effort from one location to another or from one time of year to another. This effort displacement may not actually result in an overall benefit to habitat. The potential for effort displacement was considered but not incorporated into this assessment in the interest of simplicity, and in order to categorize each specific measure as written. Certainly closing an area containing EFH to the type of fishing activities most detrimental to that habitat type is a benefit and protects the habitat from potential adverse impacts, and the Council does not wish to give the impression that closed areas are not a useful tool to mitigate habitat impacts. It is not clear, however, that this is a straightforward solution. If fishing effort is likely to shift from the closed area to another area of essential fish habitat that is also vulnerable to the fishing activity, then a closed area system may not be the best mitigation technique. It will take time to truly understand the nature of habitat vulnerability and the effects of mitigation. The Council will continue to work to develop a management program that optimizes habitat protection with the needs of the fishing industry and their communities.

The Council reviewed each management measure in place as of August 16, 1998, for the fisheries it manages. The following is a list of the management measures determined potentially to have an impact (either adverse or not) on essential fish habitat. For each measure, we have included a short discussion of the reason it was determined to affect habitat, and whether the impact is generally adverse or not. Each measure, or item within the measure, was considered as to whether there would be a greater or lesser impact on habitat if the measure did not exist. If there is the potential for there to be a greater adverse impact to habitat without the measure, the measure has a positive effect on habitat. If there is the potential that there would be less adverse impact to habitat without the measure, then the measure has a negative effect on habitat. In general, closed areas, certain types of gear restrictions, and effort controls were thought to have a more positive effect on protecting habitat. Changes in mesh size, exemptions for most fixed gear and recreational gear, minimum sizes, possession restrictions, and gear marking requirements were not thought to have any effect on habitat protection.

In the regulations associated with the northeast multispecies fisheries, exemptions are sometimes granted for certain fishing practices or gear types. Some gear exemptions may have an adverse effect on habitat by allowing certain types of fishing activities which disturb the habitat. In general, all exemptions will be evaluated to determine if allowing the exemption has the potential to threaten essential fish habitat. In several of the exemptions, an activity that has the potential to disturb the habitat may be allowed in an area where it otherwise would not occur. All exemptions need to be evaluated to determine whether any potential gear impact resulting from the exemption has a positive or negative habitat effect. According to the regulations (50 CFR 648.2), "Exempted gear, with respect to the northeast multispecies fishery, means gear that is deemed to be not
capable of catching northeast multispecies and includes:

- pelagic hook and line
- stop nets
- spears
- rakes
- diving gear
- cast nets
- tongs
- harpoons
- weirs
dipnets
pelagic longline
pound nets
pelagic gillnets
pots and traps
purse seines
shrimp trawls
surf clam / ocean quahog dredges
midwater trawls

For the purposes of this assessment, it is assumed that surf clam and ocean quahog dredges are the only exempted gears that have any direct adverse habitat impacts. All other gears on this exemption list are assumed to have negligible impact on habitat while being used for normal fishing practices. Certain gear types, however, have the potential to affect habitat if they are lost to the fishery and become ghost gear or marine debris.

648 Subpart A  General Provisions for the Fisheries of the Northeastern United States

648.1 Experimental Fishing: The Regional Administrator may grant an exemption for an experimental fishery if he/she determines that the purpose, design, and administration of the exemption is consistent with the management objectives of the respective FMP, the provisions of the Magnuson-Stevens Act, and other applicable law, as long as the exemption will not:

1. Have a detrimental effect on the respective resources and fishery;
2. Cause any quota to be exceeded; or
3. Create significant enforcement problems.

It is unlikely that an experimental fishery could meet this criteria and still have an adverse impact on EFH, so this measure in and of itself does not affect habitat. In some cases, however, it may be deemed necessary to the outcome of the experiment to allow a fishing method or gear which does impact habitat.

648.4 Vessel and individual commercial permits: see below

**NE multispecies vessels:** see below

**Replacement vessels:** Limits the horsepower and size of replacement vessels to 120% and 110% percent, respectively, of that of the vessel being replaced. This measure serves to limit the power and size of fishing vessels, and thus limits the amount of potentially detrimental gear these vessels can tow.
Upgraded vessels: Limits the horsepower and size of upgrades to 120% and 110% percent, respectively, of that of the vessel being upgraded. This measure serves to limit the power and size of fishing vessels, and thus limits the amount of potentially detrimental gear these vessels can tow.

Atlantic sea scallop vessels: see below

Replacement vessels: Limits the horsepower and size of replacement vessels to 120% and 110% percent, respectively, of that of the vessel being replaced. This measure serves to limit the power and size of fishing vessels, and thus limits the amount of potentially detrimental gear these vessels can tow.

Upgraded vessels: Limits the horsepower and size of upgrades to 120% and 110% percent, respectively, of that of the vessel being upgraded. This measure serves to limit the power and size of fishing vessels, and thus limits the amount of potentially detrimental gear these vessels can tow.

648 Subpart D  Sea Scallops

648.51 Gear and crew restrictions: Restricting the number of crew allowed on a scallop vessel has an indirect habitat effect by limiting effort, thus the area dredged/trawled.

Small dredge program restrictions: This measure has the potential to increase fishing effort by allowing scallopers of one category (part-time or occasional) to have more days-at-sea if they comply with gear and crew restrictions. It is not clear that these offset each other, but it does seem that they could get significantly more days.

Restrictions on use of trawl nets: By restricting the use of trawl nets, one gear type thought to have an impact on habitat has been limited.

648.53 Days-At-Sea allocations: Limits overall fishing time. This indirectly protects habitat by causing an overall reduction of fishing effort using some of the gears and methods likely to impact habitat.

648.54 State waters exemption: This measure has the potential to increase fishing effort above what it would be if this measure did not exist.

DAS exemption: A days-at-sea exemption potentially creates increased fishing effort. Since the principal fishing methods used in the scallop fishery have an adverse impact on certain types of habitat, this measure has a adverse impact on EFH.

Gear restriction exemption: The exemption from the previous gear restrictions has the potential to increase the use of fishing methods and gears which may be
more destructive to habitat that the fishing methods and gears which would be used if the exemption did not exist.

*Gear exemption in state waters:* In Maine, New Hampshire and Massachusetts only, the exemption from the previous gear restrictions has the potential to increase the use of fishing methods and gears which may be more destructive to habitat that the fishing methods and gears which would be used if the exemption did not exist.

648.57 **Closed areas:** The Council has temporarily closed two areas of the mid-Atlantic, the *Hudson Canyon South Closed Area* and the *Virginia Beach Closed Area*, to allow juvenile scallops in the areas to grow to a larger size than they would in the face of continued fishing pressure. The Hudson Canyon South closure represents approximately 1800 square nautical miles and the Virginia Beach closure represents approximately 500 square nautical miles of area closed to the use of scallop dredges. Thus the EFH within these areas will be afforded time to recover from the impacts associated with the use of scallop dredges.

648 Subpart F **Groundfish**

648.80 **Regulated mesh areas and restrictions on gear and methods of fishing:** The Council considered each part of this measure item by item.

*Gulf of Maine / Georges Bank Regulated Mesh Area:* see below

*Gear restrictions:* This measure allows certain exemptions from the gear restrictions in place in the GOM/GB regulated mesh area. Some of these exemptions may have a negative effect on habitat by allowing certain types of fishing gears and methods which may disturb the habitat. Each exemption will be assessed individually. In general, all exemptions are being evaluated to determine if allowing the exemption has the potential to threaten essential fish habitat.

*Scallop Dredge Fishery Exemption within the Gulf of Maine (GOM) Small Mesh Northern Shrimp Fishery Exemption Area:* By allowing dredging, an activity that could disturb the habitat has been allowed in an area where it otherwise would not occur.

*Nantucket Shoals Mussel and Sea Urchin Dredge Exemption Area:* By allowing dredging, an activity that could disturb the habitat has been allowed in an area where it otherwise would not occur.

*Southern New England Regulated Mesh Area:* see below

*SNE Mussel and Sea Urchin Dredge Exemption:* By allowing dredging, an activity that could disturb the habitat has been allowed in an area where it
otherwise would not occur.

Restrictions on gear and methods of fishing: see below

Pair trawl prohibition: This measure limits the efficiency of trawling vessels by prohibiting the practice of trawling in pairs. This measure has an effect on the efficiency of trawling, but it is not clear that the pair trawl prohibition has any impact on EFH.

648.81 Closed areas: For the year-round closed areas, the Council has determined that these areas offer significant conservation benefit to the EFH within the areas by prohibiting all bottom-tending mobile fishing gears, the gear types most often associated with adverse impacts to benthic habitats. It is important to note that on Georges Bank, the location of significant amounts of EFH for most Council-managed species, over 6,500 square nautical miles of area have been closed to bottom-tending mobile fishing gear. This equates to nearly half of the overall area of Georges Bank. For the temporary closures, the Council needs to assess the actual conservation benefits afforded EFH, if any, given that these areas are only closed for a short time each year. This length of time may not be enough time for the habitat within the areas to recover from fishing impacts.

Closed Area I: Restricts all fishing activity that could impact habitat in an approximately 1500 square nautical mile area of Georges Bank.

Closed Area II: Restricts all fishing activity that could impact habitat in an approximately 2650 square nautical mile area of Georges Bank.

Nantucket Lightship Closed Area: Restricts all fishing activity that could impact habitat in an approximately 2400 square nautical mile area of Georges Bank.

Dredge gear exception: By allowing dredging in a closed area, an activity that disturbs the habitat has been allowed in an area where it otherwise would not occur.

NE Closure Area (Aug 15 - Sep 13): Restricts all groundfish fishing activity that could impact habitat in an area of the Gulf of Maine for approximately one month during the spawning season of important groundfish. Due to the duration of the closure, it is unclear that this offers any conservation benefit to EFH.

State waters exemption: It is our interpretation that this measure is simply a clarification of the limit of the NEFMC and NMFS jurisdiction in state waters and therefore this measure has no habitat effect.

Gulf of Maine Inshore Closure Areas: Restricts all groundfish fishing activity that could impact habitat in four areas of the Gulf of Maine over a four-month period during the spawning season of important groundfish. Due to the duration
of the closures, it is unclear that this offers any conservation benefit to EFH.

*Inshore Closure Area I (March 1 - March 31):* see above.
*Inshore Closure Area II (April 1 - April 30):* see above.
*Inshore Closure Area III (May 1 - May 31):* see above.
*Inshore Closure Area IV (June 1 - June 30):* see above.

*State waters exemption:* It is our interpretation that this measure is simply a clarification of the limit of the NEFMC and NMFS jurisdiction in state waters and therefore this measure has no habitat effect.

*Cashes Ledge Closure Area (June 1 - June 30):* Restricts all groundfish fishing activity that could impact habitat in an area of the Gulf of Maine for approximately one month during the spawning season of important groundfish. Due to the duration of the closure, it is unclear that this offers any conservation benefit to EFH.

*State waters exemption:* It is our interpretation that this measure is simply a clarification of the limit of the NEFMC and NMFS jurisdiction in state waters and therefore this measure has no habitat effect.

*Western Gulf of Maine Closure Area:* Restricts all groundfish fishing activity that could impact habitat in an approximately 1200 square nautical mile area of the Gulf of Maine.

*Restricted Gear Area I / Mobile gear ban (Oct 1 - Jun 15):* Restricts a type of fishing activity that could impact habitat in an area off Georges Bank for 258 days. Due to the duration of the closure, it is unclear that this offers any conservation benefit to EFH.

*Restricted Gear Area II / Mobile Gear ban (Nov 27 - Jun 15):* Restricts a type of fishing activity that could impact habitat in an area off Georges Bank for 201 days. Due to the duration of the closure, it is unclear that this offers any conservation benefit to EFH.

*Restricted Gear Area III / Mobile Gear ban (Jun 16 - Nov 26):* Restricts a type of fishing activity that could impact habitat in an area off Georges Bank for 161 days. Due to the duration of the closure, it is unclear that this offers any conservation benefit to EFH.

*Restricted Gear Area IV / Mobile Gear ban (Jun 16 - Sep 30):* Restricts a type of fishing activity that could impact habitat in an area off Georges Bank for 107 days. Due to the duration of the closure, it is unclear that this offers any conservation benefit to EFH.

648.82 **Effort-control program for limited access vessels:** Limits overall fishing time.
This indirectly protects habitat by forcing an overall reduction of fishing effort using some of the gears and methods likely to impact habitat.

*Days-at-sea allocations:* Limits many groundfish fishermen to only 88 allowable fishing days per year.

**648.85 Flexible Area Action System:** It was determined that this measure does not currently have any habitat effect associated with it as the authority to implement this action is specifically limited to an increase in the discards of juveniles, sublegal sized adults and spawning adults.

**648.87 Gillnet requirements to reduce or prevent marine mammal takes:** No direct habitat impact, but it was noted that a potential by-product of this measure is to open up these areas (during the gillnet closures) to mobile fishing methods which may have a negative impact on the habitat. These mobile fishing methods may not be used in these areas when the closures are not in effect due to the density of fixed gear. If this is not the case, then this measure does not affect habitat.

*Mid-coast Closure Area (Mar 25 - Apr 25) and (Sep 15 - Dec 31):* Currently determined to have no habitat effect, but we may want to reexamine later based on evidence of any habitat effects of the use of “pingers.”

In summary, with the exception of the potential for impacts associated with effort displacement as a result of these measures, there are several existing management measures that directly protect EFH and others that indirectly protect EFH by reducing fishing effort. The system of closed areas on Georges Bank protects approximately 6,500 square nautical miles year-round by completely closing this area to fishing. In the Gulf of Maine, approximately 13,000 square nautical miles of habitat are afforded some degree of protection during temporary closures, with an additional 1,200 square nautical miles closed year-round. In addition, the days-at-sea program has effectively reduced much groundfishing effort to 88 days per year, and much of the scalloping effort to 142 days per year. This reduction of effort, in conjunction with the various restrictions on fishing methods and gear, has lessened the intensity of the impact of fishing on the habitat. Collie (1998) agrees that these recent Council actions to reduce effort and close important areas should reduce the impacts associated with fishing.

### 4.11 NEW MANAGEMENT MEASURES THAT AFFECT EFH

In the individual Sustainable Fisheries Act amendments, the Council is proposing several new management measures which will have the effect, either directly or indirectly, of mitigating the adverse impacts from fishing activity on EFH. These measures are designed to meet the various requirements of the Sustainable Fisheries Act, such as to conserve fish stocks, reduce overfishing, and reduce bycatch while considering the effects of management on safety at sea and on fishing communities. Considering the impacts of fishing activities on habitat, there are three principal categories of mechanisms...
that can be used to mitigate the adverse impacts: (1) closing areas to all or certain types of fishing activity; (2) restricting the use of particular gear types; and, (3) reducing the frequency and intensity of the impacts from fishing gear. Immediately prior to the submission of this amendment to the Council's fishery management plans, the Council submitted separate amendments to each of its existing FMPs, as well as new FMPs addressing Atlantic sea herring and monkfish, to address the other provisions and requirements of the Sustainable Fisheries Act. The management measures adopted in these amendments and FMPs, in some cases, provide conservation benefits to the essential fish habitat designated in this amendment. In these cases, additional management measures implemented through this amendment would be redundant and unnecessary. The following is a summary of the significant measures providing conservation benefits to EFH. For a more detailed discussion, please refer to the identified amendment or FMP.

- In Amendment 9 to the Northeast Multispecies FMP, the Council has proposed to ban the use of "streetsweeper" gear. The streetsweeper trawl is a recent gear innovation that covers the footrope with bristles resembling a streetsweeper brush. As reported by the fishermen who use the gear, the effect of this modification is that the footrope is lighter and more flexible than conventional rockhopper and roller gear. Another difference is that the entire trawl sweep (the brushes) is in contact with the bottom, rather than just the rockhoppers that are separated by hard rubber spacers which do not contact the bottom. The Council is concerned that such a net could so greatly improve the efficiency of the trawl so as to undermine the effectiveness of the DAS reduction program. The Council is also concerned that this new type of bottom trawl may have the potential to cause significant adverse effects to essential fish habitat. Since the Council has no way of assessing the impacts of the gear, it is taking the precautionary step of prohibiting it. Under current regulations, interested fishermen may propose limited, controlled experimental fisheries to determine the gear's impacts.

- In Amendment 7 to the Atlantic Sea Scallop FMP, the Council has proposed to reduced the effort in the scallop fishery by over fifteen percent for the fishing year beginning in 1999, with plans to reduce effort by another fifty-eight percent the following year. The principle mechanism to control effort in the scallop fishery is the days-at-sea management program. Prior to Amendment 7, full-time scallop vessels were allowed a maximum of 142 DAS. DAS for 1999 for full-time vessels have been reduced to 120, and will be further reduced to 50 in the year 2000 if the Council fails to act to implement other conservation measures. While there are several mechanisms that could be used to minimize the threat to EFH from scallop dredge gear, any reduction in effort would reduce the frequency and intensity of the use of scallop dredges, thus reducing the effects of fishing on the EFH of many species. The Council is actively considering additional scallop management measures which would have the potential to also provide conservation benefits to EFH, including a system of rotating closed areas. Once an area is closed for the purposes of allowing the sea scallops within the area to reach a larger size, the area will be afforded the opportunity to recover from some
of the impacts associated with scallop dredging. The Council has also recommended continuation of the mid-Atlantic closed areas, which also afford the habitat within the areas the opportunity to recover from the impacts associated with scallop dredging.

- In the Atlantic Herring FMP, the Council has not proposed any management measures which would provide any direct conservation benefit to EFH. The vast majority (92%) of herring are harvested using purse seines and midwater trawls and both gear types are believed to cause minimal, if any, adverse impact to any type of EFH. Thus, it is not believed that any measures are needed to conserve EFH from herring fishing-related activities.

- In the Monkfish FMP, the Council has not proposed any management measures which would provide any direct conservation benefit to EFH. Most vessels landing monkfish, however, will also be fishing under either a multispecies or scallop permit, and thus will be subject to those regulations, which include significant areas closed to fishing and reductions in DAS. Thus, the conservation benefits to EFH provided under the Multispecies and Sea Scallop FMPs will also be provided to the EFH likely to be impacted by the monkfish fishery.

- The EFH amendment is the only amendment to the Atlantic Salmon FMP, but since the Council is maintaining a general prohibition on the possession of Atlantic salmon in the EEZ, there can be no adverse impacts to EFH from salmon fishing to minimize. The prohibition on possession of Atlantic salmon also protects the salmon habitat areas of particular concern from any potential adverse impacts associated with the effects of fishing.

The Council may consider additional management measures for the protection and conservation of essential fish habitat from adverse impacts associated with particular fishing gear types, including the use of incentives such as allowing exemptions in closed areas if a particular fishing practice or gear type is shown not to be detrimental to habitat. The Interim Final Rule provides criteria for consideration by the Council regarding the practicability of minimizing an adverse effect from fishing. The Interim Final Rule states that the Council should consider:

- whether and to what extent a fishing activity is adversely impacting EFH;
- the nature and extent of the adverse effect on EFH; and,
- whether proposed management measures are practicable, taking into consideration the long and short-term costs as well as benefits to the fishery and its EFH, along with other appropriate factors consistent with National Standard 7 (minimize costs and avoid unnecessary duplication).

The Council has considered the known adverse impacts to EFH from the fishing-related activities in New England under Council jurisdiction. Any measures implemented by the Council to mitigate habitat impacts would likely be similar to the management measures considered in the other Sustainable Fisheries Act amendments (such as additional days-
at-sea reductions or additional closed areas). Many of the measures associated with the existing Council FMPs provide significant conservation benefit to EFH and have minimized many of the potential adverse effects associated with fishing-related activities. Several of the measures associated with the other recently submitted Sustainable Fisheries Act amendments to the Council’s FMPs provide conservation benefits to EFH and minimize potential adverse effects of fishing. These measures meet the standards of the Sustainable Fisheries Act for the Council to minimize the effects of fishing on EFH. The Council has developed modifications to the framework adjustment procedures in all of its FMPs to allow for the timely implementation of habitat conservation measures, if and when they are deemed necessary to minimize the effects of fishing on EFH. The Council also has developed a measure specifically to protect the juvenile Atlantic cod habitat area of particular concern from the most significant adverse effects of fishing-related activities.

Any measures implemented by the Council to mitigate habitat impacts would likely be similar to the management measures considered in the other Sustainable Fisheries Act amendments. Before the Council can responsibly develop additional practicable measures specifically for the protection of EFH, if they are determined to be necessary, research and analysis needs to be completed to better understand the net effects of using one particular gear design over another, as well as the effects of effort displacement that may be associated with enacting additional closed areas or reductions to the days-at-sea programs. For instance, reductions to the days-at-sea programs may have the unintended effect of forcing many fishermen to concentrate their efforts in small areas very near shore, rather than spreading their efforts out over large areas. The net effect of this type of measure could be more detrimental to EFH than no measure at all, since many types of inshore habitats are EFH. Also, since almost all areas of New England's fishing grounds are designated EFH for one species or another, a new closed area may have the unintended effect of shifting fishing effort from one area of EFH to another, concentrating effort in this other area. Due to the uncertainty associated with the actual benefits predicted from additional management measures designed to mitigate habitat impacts the Council can not conclude that the additional short and long-term costs to the fishing industry associated with those measures would be justifiable. The Council will work to better understand these issues as it strives to more narrowly refine the designations of EFH.

The Interim Final Rule suggests three options for managing the effects of fishing gear on EFH: (1) fishing equipment restrictions; (2) time / area closures; and (3) harvest limits. The Council will consider these options, among others, if additional management measures are determined to be required to prevent, mitigate, or minimize any adverse effects from fishing activities. Some fishermen, such as Mirarchi (1998) and Pendleton (1998) seem to agree that some areas, especially small areas targeted at particularly critical habitats should be protected from fishing. Additional management measures determined necessary and prudent are most likely to be implemented through the framework adjustment process.
4.11.1 Habitat Area of Particular Concern Management Measure

The following management measure has been approved by the Council. The area on Georges Bank bounded by the following coordinates and displayed on Figure 6 has been designated as a "habitat area of particular concern" for juvenile Atlantic cod. The habitat associated with this area provides critical ecological functions for the survival of post-settlement juvenile cod. The coordinates for this area are as follows:

- 67° 20' W  42° 10' N
- 67° 10' W  42° 10' N (east to the EEZ Boundary)
- 67° 00' W  42° 00' N (south to the EEZ Boundary)
- 67° 10' W  42° 00' N
- 67° 10' W  41° 50' N
- 67° 20' W  41° 50' N
- 67° 20' W  42° 10' N

The area designated as a "habitat area of particular concern" for juvenile Atlantic cod should be afforded a special level of protection. To protect this area from any potential adverse impacts from fishing-related activities, the Council will maintain the current Closed Area II restrictions, pursuant to the provisions of 50 CFR 648.81(b.), for the designated habitat area of particular concern for habitat protection reasons.

Rationale

Protection of this area from any adverse impacts caused by repeated exposure to intense disturbance will ensure suitable settlement habitat for juvenile cod in this area of Georges Bank. The objective of this measure is to improve survival of juvenile cod and increase recruitment to the fishery. This area provides two important ecological functions for post-settlement juvenile cod relative to other areas: increased survivability and readily available prey. The habitat of this area is also particularly vulnerable to adverse impacts from bottom-tending mobile fishing gear.

4.12 FRAMEWORK SPECIFICATIONS

The existing framework adjustment procedures of the Northeast Multispecies, Sea Scallop, Atlantic Herring, Monkfish, and Atlantic Salmon fishery management plans will remain in effect with the following modifications. The Council has developed framework adjustment language for inclusion in these FMPs so that habitat conservation management measures may be approved by the Council in a more timely manner than the plan amendment process. The Council also has developed framework adjustment language for inclusion in these FMPs so that the boundaries of the existing and all future essential fish habitat designations (including the designations of habitat areas of particular concern (HAPC)) may be modified in a more timely manner than the traditional plan amendment process.

The framework adjustment process allows the Council normally to modify specified plan provisions over the span of at least two Council meetings, although there is an exception.
that provides for more timely Council consideration under certain specific conditions (see 50 CFR 663, App. III. B.). The proposed modification generally will be announced in advance of at least two Council meetings and public comments will be taken at each of those meetings prior to a final Council vote on the issue.

Additionally, a document containing the measure(s) proposed, other alternatives under consideration, and the biological and economic impacts of the measures will be made available at least a week before the meeting at which the final vote is scheduled. If an action is approved, the Council forwards its recommendation to the NMFS Regional Administrator (RA). If the RA concurs with the framework adjustment, it is forwarded to the Secretary of Commerce, who has the discretion to publish it either as proposed or final regulations in the Federal Register. Adjustments which are highly controversial or make direct changes in resource allocation are usually considered for the full rulemaking process. The Secretary will publish a proposed rule with an appropriate period for public comment, followed by publication of a final rule. In other cases, the Secretary is expected to waive for good cause the requirement for a proposed rule and opportunity for public comment in the Federal Register. The Secretary, in doing so, will publish a "final rule" to remain in effect until amended, assuming that the Council process adequately satisfies the requirement for prior notice and comment.

In the existing framework process, there are other factors which are weighed during consideration of an adjustment. They include:

a) whether the availability of data on which the recommended management measures are based allows for adequate time to publish a proposed rule, and whether regulations have to be in place for an entire harvest/fishing season;

b) whether there has been adequate notice and opportunity for participation by the public and members of the affected industry in the development of the Council’s recommended management measures;

c) whether there is an immediate need to protect the resource; and,

d) whether there will be a continuing evaluation of management measures adopted following their implementation as a final rule.

For the protection of essential fish habitat in the EEZ, the Council’s recommendations on adjustments or additions to management measures must come from one or more of the following categories:

- changes to the boundaries of the EFH / HAPC designations
- gear restrictions
- changes to days-at-sea programs
- area closures
- the establishment of special management areas or zones
- seasonal closures of one or more management areas
- effort monitoring
- trip limits
- permitting restrictions
• crew limits
• onboard observers
• recreational fishing measures
• any other management measures currently included in the relevant FMP.

It is expected that as more information is made available on the distribution and relative abundance of fishery resources and on the habitat requirements and habitat relationships of the NEFMC-managed species, the Council will choose to modify and refine the boundaries of the essential fish habitat and HAPC designations. The framework adjustment process will be used to make these modifications and refinements without the need to modify all Council FMPs at one time.

The Council intends to use the above-described process to make any necessary adjustments to Council FMPs to facilitate the conservation and protection of essential fish habitat. The intent is to make changes to FMPs in a timely manner.
5.0 ANTHROPOGENIC NON-FISHING RELATED THREATS AND IMPACTS

5.1 INTRODUCTION

The Essential Fish Habitat (EFH) amendment fulfills the Magnuson-Stevens Act requirement to identify and characterize activities other than fishing that potentially reduce the quantity and/or quality of essential fish habitat. This section of the amendment will serve as a reference of non-fishing related threats and activities for the New England Fishery Management Council (Council), the National Marine Fisheries Service (NMFS), habitat management action agencies, and other interested parties. Once EFH is designated, federal agencies must consult with NMFS regarding any proposed activities that may adversely affect EFH. NMFS must provide federal and state agencies with conservation recommendations regarding any agency action that would adversely affect EFH. The Council is also empowered to comment on any federal or state agency action that would affect the habitat, including EFH, of a species under the Council’s authority. To assist with these consultation and commenting activities, this section of the EFH amendment addresses those activities most likely to reduce the quantity and/or quality of essential fish habitat. This document is not meant to provide an exhaustive review and analysis of the impacts of all potentially detrimental activities; yet, it should highlight notable threats and provide enough information to determine if further examination of a proposed activity is necessary.

The northwest Atlantic, including the Gulf of Maine, Georges Bank, and portions of the continental shelf south of New England (e.g. Nantucket Shoals), supports a number of commercial, recreational and non-commercial fish and invertebrates and provides essential habitat for the reproduction, development, growth, feeding, and sustainability of these fishery resources. Management plans regulate fishery harvest in the northwest Atlantic; however, continual adverse human impacts, including non-fishing and fishing activities, and natural disturbances have contributed to the depletion of fishery resources and associated biological, chemical and physical environmental conditions. Adverse effects of non-fishing activities are of particular concern for the maintenance of a healthy ecosystem in riverine, coastal, and offshore habitats of the New England region.

The three subregions of the New England marine habitat differ in topography and oceanography and are a heterogeneous and dynamic environment with notable spatial and temporal variations (Buchholtz ten Brink et al. 1996). The offshore bottom type within the Gulf of Maine is quite patchy and generally related to topography (Schlee 1973) and is characterized by deep basins containing silty clay or clay sediments with topographic peaks covered with sand and gravel (NEFMC 1993). Coastal benthic habitat south of Casco Bay, ME is largely sand, and to the north and east is generally a finer proportion of silt and clay (Schlee 1973). Georges Bank is a shallow elongate extension of the northeastern U.S. Atlantic continental shelf which is covered by glacial debris that ranges from very coarse gravel to sand (Valentine et al. 1993) with scattered boulders (Collie et al. 1997). The southern New England region is broad and flat and is characteristically sand with patches of gravel (NEFMC 1993). Riparian habitats located along the coast of New England provide essential habitat to anadromous fishes and are critical to chemical conditions (e.g. salinity) of coastal environments.
The biological, chemical and physical requirements of specific aquatic and marine organisms throughout their life history demonstrate the evolutionary adaptation to particular habitats for successful, healthy and sustainable populations. Sediment type has been directly associated with biological characteristics in the New England marine environment (Langton et al. 1995). In particular, fish species (e.g. Gadidae) and bottom topography have been positively related on Georges Bank (Valentine and Lough 1991).

Tidal current velocity and substrate type have been associated with the spawning and settling behavior of marine organisms (e.g. Clupeidae and Placopecten magellanicus) (Sinclair and Iles 1985; Collie et al. 1997).

Coastal nursery habitat, including surf zones, estuaries, tidal creeks and channels, is essential for the development of many anadromous, estuarine, and marine fish and invertebrates. For instance, aquatic vegetation is very productive and performs a number of critical ecological functions, which include providing food and shelter for commercial, recreational and non-target organisms (Thayer et al. 1997) (Section 2.6.5). Other complex habitats within aquatic and marine regions (e.g. oyster and mussel beds) may offer important features for survivorship and development of fish and shellfish. Marine and aquatic organisms require specific nursery habitats for development.

Habitat alteration and disturbance occurs from natural processes and human activities. Natural disturbances to habitat can result from summer droughts, winter freezes, and heavy precipitation, and strong winds, waves, currents and tides associated with major storms (i.e. hurricanes and northeasters), along with world-wide climatic changes. Biotic factors, including bioturbation and predation, may also disturb habitat (Auster and Langton 1998). These natural events may have detrimental effects on habitat, including disrupting and altering biological, chemical and physical processes, and may impact fish and invertebrate populations. Potential adverse effects to habitat from fishing and non-fishing activities may include direct (e.g. contamination or physical disruption), indirect (e.g. loss of prey or reduction of species diversity), site-specific or habitat-wide impacts, including individual, cumulative or synergistic consequences of the actions. Non-fishing threats to habitat may include the intentional or accidental discharge of contaminants (i.e. heavy metals, oil, nutrients, pesticides, etc.) from non-point and point sources, and direct habitat degradation from human activities (i.e. channel dredging, marina / dock construction, etc.).

For the purposes of this document, the following definitions and descriptions apply throughout the text.

- **Riverine regions** are freshwater streams, rivers, and streamside wetlands including banks and associated vegetation that may be bordered by other freshwater habitats (e.g. palustrine emergent, scrub-shrub, or forested vegetation) (Pedevillano 1995).

- **Inshore regions** are coastal marine and estuarine environments, including rocky intertidal areas, exposed beaches, mudflats, salt marshes, seagrass flats, kelp beds, near-shore rocky bottoms, near-shore soft bottoms, tidal inlets, and other coastal habitats (Moyle and Cech 1988). The neritic waters (i.e. pelagic zone of the
continental shelf and inshore waters) are important to a variety of estuarine and marine fishes and invertebrates. Inshore habitats are dynamic and heterogeneous environments which support the majority of marine and anadromous fishes at some stage of ontogeny.

- **Offshore regions** are open-waters, including habitat seaward of the inshore designation. Offshore benthic habitat features include sand waves, shell aggregates, gravel beds, boulder reefs, and submerged canyons which provide nursery requirements for demersal fishes (Auster 1997). The pelagic zone (e.g. epipelagic, mesopelagic, and bathypelagic) presents notable environmental features in offshore waters. Many marine organisms inhabit the stable offshore environment for substantial stages of their life history.

- A **threat** is defined as any chemical, biological or physical stress that may diminish, disrupt, degrade or eliminate essential fish habitat.

Healthy riverine, inshore and offshore ecosystems are crucial for the sustainability of ecological productive capacity, diversity of flora and fauna, and the ability of the environment to regulate itself. A healthy ecosystem should be similar to comparable, undisturbed ecosystems with regard to standing crop, productivity, nutrient dynamics, trophic structure, species richness, stability, resilience, contamination levels, and frequency of diseased organisms. The main goal for the identification of non-fishing adverse effects is to promote an awareness of the number of non-fishing threats that potentially impact EFH. To achieve this goal, this section of the EFH amendment addresses the following specific objectives:

1. Identify the non-fishing threats, sources, and activities that have the potential to adversely affect EFH quantity, quality, or both.

   The source and impacts (short- and long-term) of the chemical, biological or physical threats and activities are addressed. These threats are identified in order to lessen actions potentially contributing to non-point and point source discharge and physical habitat alteration, that may eliminate, diminish or disrupt the function of EFH. The identification of chemical, biological and physical threats will assist in developing conservation and enhancement recommendations to avoid, minimize or compensate for these adverse impacts to EFH (see Section 6.0).

2. **Discuss particular areas in New England that documented non-fishing threats occur.**

   Past, current, and potential areas that may be impacted by stresses and human activities are noted to assist in the mitigation of these sources of habitat degradation. Vulnerable habitats may include but are not limited to past sites of sludge disposal, known discharge sites, and potential mining areas. Nursery areas of notable resource value (e.g. submerged aquatic vegetation, cobbles, gravel, etc.) are also addressed.
5.2 IDENTIFICATION OF NON-FISHING THREATS OF THE NEW ENGLAND REGION

Riverine, inshore and offshore habitats are subject to numerous chemical, biological and physical threats (Table 10). Inshore and riverine habitat is being degraded and altered by many human activities and sources of degradation. Deep-sea habitats (e.g. offshore region) are relatively stable and contain less resilient communities than habitats found within inshore waters (Radosh et al. 1978). Offshore environmental conditions are often altered by unnatural stress. The pelagic environment within coastal and offshore potentially presents essential habitat conditions for many marine organisms throughout substantial stages of ontogenetic development. These areas can also be disrupted. Chemical, biological, and physical threats potentially limit survivorship, growth, and reproduction rates of finfish and shellfish species and populations in New England.

Table 10: Potential non-fishing threats to fish habitat in the New England region prioritized within regions (● = high; ○ = moderate; ◆ = low)¹.

<table>
<thead>
<tr>
<th>THREATS</th>
<th>RIVERINE</th>
<th>INSHORE</th>
<th>OFFSHORE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chemical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>oil</td>
<td>●</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>heavy metals</td>
<td>●</td>
<td>●</td>
<td>○</td>
</tr>
<tr>
<td>nutrients</td>
<td>◆</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>pesticides</td>
<td>●</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>herbicides / fungicide</td>
<td>●</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>acid</td>
<td>●</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>chlorine</td>
<td>●</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>thermal</td>
<td>●</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>metabolic &amp; food wastes</td>
<td>●</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>suspended particles</td>
<td>●</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>radioactive wastes</td>
<td>◆</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>greenhouse gases</td>
<td>●</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Biological</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nonindigenous / reared species</td>
<td>●</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>nuisance / toxic algae</td>
<td>●</td>
<td>●</td>
<td>○</td>
</tr>
<tr>
<td>pathogens</td>
<td>●</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
## Threats

<table>
<thead>
<tr>
<th>Physical</th>
<th>Riverine</th>
<th>Inshore</th>
<th>Offshore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel dredge</td>
<td>⬤</td>
<td></td>
<td>⬤</td>
</tr>
<tr>
<td>Dredge and fill</td>
<td></td>
<td>⬤</td>
<td></td>
</tr>
<tr>
<td>Marina / dock construction</td>
<td></td>
<td>⬤</td>
<td></td>
</tr>
<tr>
<td>Vessel activity</td>
<td></td>
<td></td>
<td>⬤</td>
</tr>
<tr>
<td>Erosion control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulkheads</td>
<td></td>
<td></td>
<td>⬤</td>
</tr>
<tr>
<td>Seawalls</td>
<td></td>
<td></td>
<td>⬤</td>
</tr>
<tr>
<td>Jetties</td>
<td></td>
<td></td>
<td>⬤</td>
</tr>
<tr>
<td>Groins</td>
<td></td>
<td></td>
<td>⬤</td>
</tr>
<tr>
<td>Tidal restriction</td>
<td></td>
<td>⬤</td>
<td></td>
</tr>
<tr>
<td>Dam construction / operation</td>
<td></td>
<td></td>
<td>⬤</td>
</tr>
<tr>
<td>Water diversion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water withdrawal</td>
<td></td>
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<td>⬤</td>
</tr>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deforestation</td>
<td></td>
<td></td>
<td>⬤</td>
</tr>
<tr>
<td>Mining</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravel/mineral mining</td>
<td>⬤</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil/gas mining</td>
<td></td>
<td>⬤</td>
<td></td>
</tr>
<tr>
<td>Peat mining</td>
<td></td>
<td></td>
<td>⬤</td>
</tr>
<tr>
<td>Debris</td>
<td></td>
<td>⬤</td>
<td></td>
</tr>
<tr>
<td>Dredged material disposal</td>
<td></td>
<td>⬤</td>
<td></td>
</tr>
<tr>
<td>Artificial reefs</td>
<td></td>
<td></td>
<td>⬤</td>
</tr>
</tbody>
</table>

1. Prioritization developed by compilation of EFH Technical Team survey.

The major threats to marine and aquatic habitats are a result of increasing human population and coastal development which is contributing to an increase of human generated pollutant loadings. These pollutants are being discharged directly into riverine and inshore habitats by way of point and non-point sources of pollution. The development of coastal regions to accommodate more people leads to an increase in impervious surfaces, including but not limited to roads and parking lots. Impervious surfaces cause greater volumes of run-off and associated contaminants into aquatic and marine waters. Golf courses are one of several examples of alteration of hydrology that contribute a substantial source of contaminated run-off that potentially impact fishery resources. Humans attempt to control and alter natural processes of aquatic and marine environments for an array of reasons, including industrial uses, coastal development, port and harbor development, erosion control, water diversion, agriculture, and silviculture. Environmental conditions of fish and shellfish habitat are altered by human activities (see Wilk and Barr 1994 for review) and threatened by non-point and point sources of pollution (Table 11).
<table>
<thead>
<tr>
<th>NON-POINT SOURCES</th>
<th>ACTIVITIES &amp; POINT SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>run-off (municipal¹ / agricultural)</td>
<td>industrial discharge⁴</td>
</tr>
<tr>
<td>atmospheric deposition</td>
<td>power plants⁵</td>
</tr>
<tr>
<td>wildlife feces²</td>
<td>sewage treatment plants</td>
</tr>
<tr>
<td>industrial shipping</td>
<td>ocean disposal of dredged material</td>
</tr>
<tr>
<td>recreational boating³</td>
<td>aquariums</td>
</tr>
<tr>
<td>septic systems</td>
<td>biotechnology labs</td>
</tr>
<tr>
<td>contaminated groundwater (²°)</td>
<td>silviculture (forestry)</td>
</tr>
<tr>
<td>contaminated sediments (²°)</td>
<td>water diversion</td>
</tr>
<tr>
<td>nuisance / toxic algae (²°)</td>
<td>decaying shoreline structures</td>
</tr>
</tbody>
</table>

¹ municipal run-off includes, but not limited to, sewer overflows
² wildlife is defined as animals other than domesticated livestock and pets
³ includes fishing boats, pleasure cruisers, jet skis, etc.
⁴ may include pulp and paper mills, tanneries, textile mills, metal fabricating and finishing operations, chemical, plastic, rubber, electronic, equipment manufacturing plants, etc.
⁵ includes nuclear, hydropower, and fossil fuel burning plants
⁶ includes mining, pipeline transport, and other byproducts from the particular industry
- aquaculture impacts are discussed in section 4.7

5.3 THREATS TO RIVERINE EFH

New England rivers historically supported large runs of native Atlantic salmon (*Salmo salar*). Freshwater habitat is necessary for the growth, survivorship, and reproduction of salmon and represent an important historic commercial and recreational fishery. Atlantic salmon abundance, distribution and ontogenetic development has been studied extensively because of poor population levels (see FWS 1995 for review). Among the major identified causative factors of the population demise of Atlantic salmon, non-fishing related activities may be the most dramatic. Chemical, biological and physical threats to fish habitat in riverine environments, including both terrestrial and aquatic sources, have led to habitat disruption and degradation. Also, rivers may assist in the transport of non-point and point sources of contamination to nearshore environments.
implicating marine organisms.

5.3.1 Chemical Threats

Oil (defined as any hydrocarbon or petroleum substance) can degrade riverine habitat, consequently interfering with biotic communities. Oil may be discharged into rivers from both non-point and point sources, including municipal and agricultural run-off, industrial shipping, recreational boating, contaminated sediments, power plant discharge, marine transportation, energy and mineral exploration and transportation, and disposal of dredged material. Oil potentially interferes with reproduction, development, growth, and behavior of aquatic organisms (see Gould et al. 1994 for review). Benthic habitat and the shoreline can be covered and destroyed by oil. Oil has been demonstrated to disrupt the growth of freshwater vegetation (Lin and Mendelssohn 1996). Long-term exposure to oil may lead to the disruption of population dynamics of aquatic communities. Rivers may also transport oil to adjacent estuaries and inshore habitats that are important areas for marine and aquatic organisms.

Heavy metals entering riverine habitats from municipal and agricultural run-off, contaminated groundwater and sediments, industrial shipping, recreational boating, atmospheric deposition (non-point sources), industrial discharge, power plants, disposal of dredged material, and marine transportation (point sources) can negatively impact fish habitat. New England rivers were heavily loaded with metals during the nineteenth century from industries dependent on hydropower (Larsen 1992). Metal contaminants are found in the water column and persist in sediments (Buchholtz ten Brink 1996) and may inhibit reproduction and development of aquatic organisms. Fish and invertebrates may be directly killed by lethal concentrations of heavy metals, especially early life history stages (Gould et al. 1994). Heavy metals have also been implicated in disrupting endocrine secretions of aquatic organisms, potentially disrupting natural biotic properties (Brodeur et al. 1997). Long-term impacts may not be noticeable in riverine fish; however, heavy metals may cascade through trophic levels, accumulate in fish, and eventually cause health problems in humans.

Aquatic environments depend on nutrients to control the productivity of fishery resources; however, an excess of nutrients discharged into the environment can degrade habitat (ASMFC 1992; NOS 1997). Nutrient over-enrichment can cause eutrophication that has disrupted many aquatic systems (see O’Reilly 1994; Wilk and Barr 1994). Excess nutrients entering riverine habitat originate from non-point sources, including municipal and agricultural run-off, contaminated groundwater and sediments, atmospheric deposition, septic systems, industrial shipping, recreational boating, wildlife feces, and nuisance / toxic algae, and point sources, including industrial discharge, sewage treatment plants, water diversion, disposal of dredged material, silviculture, energy and mineral exploration, and aquariums. Eutrophic habitats are characterized by low dissolved oxygen (anoxia is possible), high turbidity, phytoplankton and filamentous algal blooms, and inhibited denitrification. Severe eutrophic conditions can reduce the amount of aquatic vegetation (Goldsborough 1997), cause mass mortality of aquatic organisms, and alter long-term community dynamics. Harmful algal blooms (HABs) associated with unnatural aquatic nutrient levels have been associated with fish disease
Pesticides and herbicides from agricultural and municipal run-off, atmospheric deposition, contaminated groundwater (non-point sources), water diversion, and disposal of contaminated dredged material (point sources) have killed aquatic organisms and accumulated in the benthos. Herbicides are also frequently used to inhibit colonization of boat hulls and pipes by micro-algae and subsequent growth of seaweeds (Readman et al. 1993). Pesticides may be re-released to the environment during substrate disturbance causing habitat disruption and degradation. Aquatic organisms may accumulate pesticides within tissues which potentially cause health problems in humans. Pesticides also have gained recent attention as being endocrine disrupters of aquatic organisms. The chemicals may also cause mortalities of aquatic insects which contribute to the food base of salmonids (USFWS 1995). Herbicides may alter long-term natural community structure by hindering plant growth or directly destroying vegetation. The combination of pesticides and herbicides contribute to the degradation of aquatic habitat (see Meyers and Hendricks 1982 for review).

The influx of acid to riverine environments can cause severe habitat degradation and disruption. The freshwater environment does not have the buffering capacity of marine ecosystems, so acidification has serious implications on riverine habitat. Acidification potentially disrupts or prevents reproduction, development, and growth of aquatic fish and invertebrates (USFWS 1995). Low pH (< 5.0) has been implicated with osmoregulation problems (Staurnes et al. 1996), pathological changes in eggs (Peterson et al. 1980; Haines 1981), and reproduction prevention (Watt et al. 1983) of Atlantic salmon. Periodic and long-term discharge of acid into aquatic environment can disrupt and destroy important fish and shellfish habitat. Major non-point sources of acid include agricultural and municipal run-off, contaminated groundwater, and atmospheric deposition, and point sources include industrial and sewage plant treatment discharge.

Substances containing chlorine compounds [e.g. organochlorides – polychlorinated biphenyls (PCBs)] can disrupt and degrade aquatic habitats. Chlorine can exert acute and sublethal effects on aquatic organisms (Sasikumar et al. 1993; Manning et al. 1996), especially early life history stages (Hose et al. 1989). The USEPA water quality criteria state that chlorine discharge should not exceed 11 µg/L as a four-day average and 19 µg/L as a one-hour average more than once every three years (USEPA 1986). Septic systems, contaminated groundwater, industrial and sewage treatment plant discharge, and power plants are potential sources of chlorine that can lower habitat quality or directly kill aquatic organisms. Also, chlorinated compounds are used to inhibit the settlement of biofouling organisms. Long-term chlorine effluent can change habitat quantity and quality and disrupt population dynamics.

Dams, power plants, and industrial facilities produce thermal effluents in aquatic habitats which potentially cause thermal shock to organisms. The benthic community may be changed by the unnatural water temperature discharged. Aquatic organisms, especially early life history stages, can be directly killed by thermal plumes. Water temperature influences biochemical processes of the environment, behavior of aquatic organisms, and
community assemblages. Altering the natural temperature regime, potentially changes indigenous habitat characteristics and associated biotic communities. Forestry activities, including clear-cutting or loss of riparian habitat, also contributes to higher water temperatures that may disrupt and degrade habitat conditions.

Agricultural facilities, septic systems, wildlife feces, nuisance / toxic algae (non-point source), livestock waste, and sewage treatment plants (point sources) are sources of organic wastes potentially impacting habitat. Metabolic wastes, excess food, and organic fertilizers entering riverine environments can increase levels of nutrients and pathogens, lead to eutrophication, and alteration of local benthic dynamics. Long-term influx of organic wastes may degrade the quantity and quality of habitat.

Fish and invertebrate habitat may be negatively impacted by an unnatural influx of suspended particles (Arruda et al. 1983). Lethal and sublethal impacts to riverine organisms may occur with various concentrations of suspended sediments (Barr 1993). Erosion and watershed development can contribute suspended sediments entering riverine environments thus embedding particulate in benthic habitat and making it unsuitable habitat (USFWS 1995). Particulate matter also enters riverine habitats from non-point source municipal and agricultural run-off, industrial shipping, and recreational boating, and point source industrial discharge (e.g. pulp mills), dredging, ocean disposal of dredged material, water diversion, energy and mineral exploration and transportation, erosion control, silviculture, and marine transportation. Short-term impacts of an increase in suspended particles include high turbidity, reduced light, and sedimentation which may lead to the loss of benthic structure and disrupt the overall productivity streams (USFWS 1995). Other problems associated with suspended solids include disruption of respiration, water transport rates, filtering efficiency of fishes and invertebrates, sorption of metals and organic materials, reduction of growth and survival of filter feeders, and decreased foraging efficiency of sight feeders. Fry and parr find refuge within interstitial spaces provided by gravel and cobble that are potentially clogged by sediments and subsequently decrease survivorship (USFWS 1995). Toxic metals and organics absorbed by suspended solids may recur and become more available to aquatic organisms in the habitat when disturbed (e.g. dredging). Resuspension of sediments may supply nutrients to the water column that are needed for primary production. However, increased flux of nutrients into the water column may stimulate phytoplankton production and contribute to increased turbidity and alteration of nutrient cycles. Frequent high levels of suspended particles can lead to the loss of habitat for aquatic creatures.

Radioactive wastes may be a potential threat degrading aquatic habitat used by fish and shellfish species. Fishery resources may accumulate radioactive isotopes in tissues posing problems for the resource and consumers (ICES 1991). Long-term exposure to radioactive wastes may alter the natural dynamics of the habitat. Potential sources of radioactive wastes are municipal run-off, atmospheric deposition, contaminated groundwater and sediments (e.g. past dumping locations) (non-point sources), and industrial and power plant discharge (point sources).
Global warming presents an array of potential impacts on riverine habitats (Lehtonen 1996). Global warming may be accelerated by the continued release of greenhouse gases from the burning of fossil fuels and forests and using aerosol-producing substances (i.e. the greenhouse effect). Greenhouse gases, including carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons, are discharged into the atmosphere from respiration of all living organisms, burning fossil fuels and forests, and using aerosols. Possible impacts on riverine habitats from global warming and subsequent sea level rise are the loss of wetlands, salinization of freshwater environments (eliminating freshwater supplies), and change in natural biotic characteristics [e.g. shift in fish composition to cyprinid and percid dominance with the decline of salmonid populations (Lehtonen 1996)] and abiotic properties (e.g. currents and nutrient availability). Sea levels have fluctuated through the history of earth and have been rising since the end of the Pleistocene. Tectonic and postglacial isostatic adjustments and effects of atmospheric temperature contribute to changes in the rate of sea level rise (Valiela 1995). The change in the rate of sea level rise may alter freshwater riverine habitats. Freshwater wetlands, which have an array of important functions, may be unable to accrete fast enough to keep pace with sea level rise, or unable to accrete because of the development of land.

5.3.2 Biological Threats

The introduction of nonindigenous species or the escapement of farmed organisms entering the environment has been documented (Rosecchi 1993; USFWS 1995) and can threaten habitat. Human activities are closely tied to exotic introductions. Non-native plants (e.g. Phragmites) potentially degrade riverine habitat by changing natural qualities. New diseases may be introduced and spread throughout the habitat with the release of exotic organisms. Exotic and reared fish, shellfish, plants, and pathogens enter riverine habitats from industrial shipping (e.g. ballast water), recreational boating (non-point sources), biotechnology, aquariums, and aquaculture (addressed in Section 4.7) (point sources). Native populations and habitat are threatened by escapement and release of nonindigenous organisms. Introduced fish, shellfish, and plants compete with or forage on wild organisms which can change habitat characteristics and hinder the success of fisheries dependent on rivers. Long-term natural community structure and dynamics may be changed with the introduction of organisms through altering the genetic diversity of wild stocks, transmitting diseases, and changing biotic assemblages.

Harmful algal blooms (HABs) have been associated with unnatural levels of nutrients in riverine habitats. HABs have detrimental impacts to habitat and toxic effects on organisms and humans (see O’Reilly 1994; Boesch et al. 1997). Organisms responsible for HABs have naturally occurred in the environment for a long time, so the apparent increase of bloom events may simply reflect better detection of natural phenomena (NSF and NOAA 1998). However, the current intensity and frequency of HABs compared to the past appears to indicate more toxic algal species, more algal toxins, more areas affected, more fishery resources affected, and higher economic losses (Boesch et al. 1997; NSF and NOAA 1998). Nonindigenous algal species may be introduced to the environment from ballast water of commercial vessels, recreational boating, shellfish transfer (e.g. seeding), dredging, and disposal of sediments (Boesch et al. 1997) adding to the potential problem of blooms. HABs can indicate eutrophic conditions, alter, impair,
or kill plankton and fish communities, smother indigenous vegetation, and lower dissolved oxygen (NOAA 1997). Certain toxic organisms (e.g. *Pfiesteria* spp.) are associated with HABs and have caused major outbreaks of disease and fish kills (NCSU 1998). These short-term impacts can eventually change the natural processes of habitat, reducing viable fish and shellfish populations.

The spread of disease among aquatic organisms may adversely impact riverine habitat. Pathogens introduced inadvertently or purposely may spread diseases which can be lethal or sublethal to fish and shellfish. Diseases and parasites enter the environment through agricultural and municipal run-off, septic systems, wildlife feces, industrial shipping, recreational boating (non-point sources), disposal dredged material, biotechnology, aquariums, and sewage treatment plants (point sources). Human influences, including nutrient over-enrichment, have been shown to stimulate outbreaks of pathogens (NCSU 1998). The toxic dinoflagellate, *Pfiesteria piscicida*, has been implicated as the primary causative agent of many fish kills and disease episodes (Burkholder *et al.* 1992; NCSU 1998). Atlantic salmon are susceptible to a number of diseases and parasites, including the gill maggot (*Salmincola salmonea*), freshwater louse (*Argulus foliaceus*), leech (*Piscicola geometra*), trematodes, cestodes, acanthocephalans, nematodes, sea louse (*Lepeophtheirus salmonis*), sea lamprey (*Petromyzon marinus*), and numerous bacterial, viral, and fungal diseases (see USFWS 1995). Disease outbreaks and fish kills may have cascade effects through the environment by altering community structure and transferring toxins through the trophic web. Continual disease outbreaks may have long-term implications on the success of fish and shellfish populations in riverine habitat.

**5.3.3 Physical Threats**

Channel dredging is a frequent long-term maintenance activity associated with shoreline development, port and harbor development, and vessel activity (see Barr 1987). The increased need for channel dredging has resulted from increased marine transportation, increased vessel size, expansion of commercial fleets, and alterations in sedimentation patterns of rivers due to increased settlement and urbanization (Messieh *et al.* 1991). The short-term impacts to habitat can be substantial. Dredging resuspends sediments (see Section 5.3.1) and associated contaminants and potentially degrades habitat quality and fish populations. Changes in water quality, depth, water temperature, current velocity, bottom topography, and sediment type are associated with dredging of channels. The changes can decrease dissolved oxygen and SAV distribution and density while smothering the surrounding benthic community. The channel can increase the transport of sediment and siltation of riparian habitat resulting in alteration of feeding, spawning, and refuge habitat. For example, cobble or gravel streambed may be covered, consequently decreasing the amount of refuge habitat available for early life history stages of fish (USFWS 1995). Fragmentation of habitat can hinder the movements (i.e. dispersal, recruitment, migrations, etc.) of organisms. The continual maintenance involved with channel dredging can eventually change the indigenous habitat and population dynamics of the region.

The dredging and filling of wetlands for shoreline, coastal, port, and harbor development directly removes potentially important habitat and alters the habitat surrounding the developed area. The direct removal of riverine habitat from dredge and fill activities may
be one of the biggest threats to riverine habitats and the success of freshwater and anadromous organisms. Dredge and fill activities reduce the wetland functions (i.e. retain floodwater and uptake nutrients) and decrease the amount of detrital food source available to biotic communities. Hydrological modifications from dredge and fill activities and general coastal development (e.g. golf courses) may increase the amount of run-off entering the aquatic environment that may contribute to the degradation of fishery resources. Along with these specific impacts of wetland dredge and fill activities, the short- and long-term impacts are similar to channel dredging.

Marina and dock construction is an inevitable result of shoreline development. Port development has been implicated in disrupting important riverine habitat for salmonids and clupeids (Levings 1985). The construction of marinas and docks aggregates contaminants associated with the vessels that use the facilities. Along with contamination of the habitat, the construction of marinas changes habitat parameters such as water quality, depth, water temperature, current velocity, and SAV and benthic composition, distribution, and abundance. SAV is removed during construction and shaded by the physical structures after construction eventually destroying the vegetation. Sedimentation patterns are changed because of the change of current velocity and pattern. Sedimentation may occur at greater rates which may depleted the amount of habitat available for spawning, foraging, and development. Mooring chains located in riverine environments may degrade habitat conditions by disrupting benthic features. Repeated small-scale habitat loss can have cumulative effects and can fragment habitat which can have a detrimental impact on fish and shellfish stocks. The long-term presence of marinas can contaminate the localized area and change natural habitat qualities and population dynamics in the region.

Vessel activity, including industrial shipping, recreational boating, and marine transportation (e.g. ferry transportation), may contribute to the physical degradation of aquatic habitats and related organisms. Increased vessel activity within riverine waters is directly related to the increase in shoreline, port and harbor development. The benthos, shoreline and pelagic habitat may be disturbed or altered from vessel use in riverine regions. The severity of disruption on riverine processes may depend on the size of the river (i.e. depth, width, and length), vegetation type on river bank, current speed, composition of sediments in the river bed, and type of boat traffic (Yousef 1974; Karaki and vanHoften 1975; Barr 1993).

- The direct disturbance of bottom topography (e.g. prop scarring) results in increased turbidity (see Section 5.3.1 for further details) which can lead to the loss of SAV, nursery and forage habitat adversely affecting benthic communities (Yousef 1974; Hilton and Phillips 1982; Barr 1993). Vessel-induced disturbance of surficial sediments rich in nutrients may indirectly contribute to nutrient over-enrichment of riverine habitats (Barr 1993). Vessels coming in direct contact with surficial sediments may contribute to siltation of riverine habitats. The destruction of SAV, either by direct prop disturbance or increased turbidity, and the disturbance or siltation of riparian habitat (i.e. gravel) may consequently fragment, decrease quality, and/or destroy large areas of habitat.
- Elevated wakes caused by industrial and recreational shipping and transportation can have substantial impacts on aquatic shoreline and backwater areas. Wave activity intensifies with increase of riverine boat traffic (Karaki and vanHoiten 1975). The continual disturbance of water along frequently traveled routes can lead to shore erosion, substrate disturbance, increase turbidity, pelagic disturbance, and spillage to backwater areas which can eventually cause the loss of habitat (Karaki and vanHoiten 1975; Barr 1993).

Watershed development can contribute to erosion and sedimentation of aquatic habitats. Bulkheads are rigid structures built parallel to the shoreline for erosion control (Leatherman 1988) that can alter habitat by eliminating the land-water interface and changing run-off patterns. Changing the land-water interface may actually increase erosion along the shoreline. Sedimentation of benthic habitat may occur with erosion, degrading important fish habitat. Benthic community structure can be degraded or removed adding to the disruption of fish habitat. The long-term presence of bulkheads can lead to severe erosion and sedimentation and change natural habitats and associated biotic dynamics of the region.

Development of the shoreline may include structures which restrict water movements (i.e. roads, bridges, dikes, etc.). Natural drainage, current, and sedimentation patterns can be hindered by the construction of tidal restricting structures. Physicochemical properties (i.e. water temperature, dissolved oxygen, flow, etc.) are altered changing the habitat characteristics that may hinder migratory, spawning, feeding and dispersal movements of aquatic organisms resulting in depleted stocks of fish and invertebrate species. Sedimentation of riparian habitat may increase because of increased erosion and changed current patterns. Confined aquatic habitats with restricted water exchange may allow HABs to persist (Boesch et al. 1997). The hindrance or blockage of tidal flushing and associated biotic movements can degrade associated habitat by altering the natural dynamics.

Dam construction and operation occurs within New England riverine habitat for flood control, power generation, navigation, and reservoir formation. The construction of dams with either inefficient or non-existent fish ways was the primary agent of the population decline of U.S. Atlantic salmon (USFWS 1995). Historical records link the decline of Atlantic salmon with construction of dams (USFWS 1995 for review). Dams alter water flow and sedimentation patterns, depth, water temperature, water quality, and stream bed properties. Salmonids are threatened by unnatural condition created by dams, including passage over spillways, passage through turbines, passage through impoundments (Ruggles 1980), and entrainment and impingement. Migration of fishes is hindered or blocked. Fishes are impinged and entrained, and exposed to dissolved gas supersaturation, aggregated contaminants, and high concentrations of predators and disease in the habitat surrounding dams. The disruption of fish development can change the natural habitat and fishery dynamics of aquatic habitat. The loss of wetlands by the reduction of freshwater input and sediments can have potentially serious impacts on both fish and invertebrate populations.

Natural freshwater flows are subject to human alteration through water diversion and use and modifications to the watershed (i.e. deforestation, tidal restrictions, and stream
channelization) (Boesch et al. 1997). Water withdrawal for freshwater drinking supply, power plant coolant systems, and irrigation occurs along urban and agricultural coasts causing potential detrimental effects on aquatic habitats and is associated with coastal development. The mass flow of water into a power plant and other reservoirs results in entrainment and impingement of fishes (especially early life-history stages of fish). Larval and juvenile demersal fishes along with invertebrates are susceptible to entrainment and impingement around intake pipes (ASMFC 1992). Important habitat is lost for aquatic organisms that are not capable of recruiting and settling around the intake and may adversely affect fish and shellfish populations by adding another source of mortality to the early life stage which often determines recruitment and strength of the year-class (Travnichek et al. 1993). Water withdrawal and diversion along with anthropogenic watershed changes have been related to the increase in some HABs (Boesch et al. 1997) impacting aquatic and marine habitat. The continued diversion and use of water from coastal waters can lead to degradation of fish and shellfish habitats.

- Freshwater is becoming limited because of natural events (e.g. droughts), increasing demand of potable water, and inefficient use. Freshwater is withdrawn for human use from riverine environments. The withdrawal of water can alter natural current and sedimentation patterns, water quality, water temperature, and associated biotic communities.

- Irrigation for agriculture alters currents, water quality, water temperature, depth, and drainage and sedimentation patterns of aquatic habitat. Sedimentation within rivers can hinder benthic processes and communities. Irrigation can also increase run-off containing materials (i.e. heavy metals, nutrients, etc.) which stress the habitat. The changes to the natural habitat caused by irrigation can potentially lead to changes in the dynamics of aquatic organisms.

The growth and harvest of forestry products is a major land use of much of watershed in New England that can have short- and long-term impacts that may adversely affect riverine habitat (USFWS 1995). Silviculture practices and shoreline development lead to the removal of vegetation, an increase of impervious surfaces, and decrease of the water retention of watersheds. These watershed changes may result in inadequate river flows, increase of stream bank and stream bed erosion, sedimentation of riparian habitat, and an increase of run-off and associated contaminants (e.g. herbicides). Hydrologic characteristics (e.g. water temperature) are changed and greater variation in stream discharge is associated with the forestry industry (USFWS 1995). Debris (i.e. wood and silt) are released into the water as a result of the harvest of the forest which can smother benthic habitat. Deforestation can alter or impair natural habitat structures and dynamics.

Mining is a potential problem within riverine habitats. Mining can have direct and indirect chemical, biological, and physical impacts to the habitat of the mining site and surrounding regions. Structures are built within habitats to assist in mining and transporting materials. In a review by Pearce (1994), the effects of mining have been listed as: (1) destruction of existing benthic biotic community; (2) resuspension of sediments with negative impacts on fishery resources (see Section 5.3.1); (3) changes in bottom topography and sediment composition; and (4) consequences related to the
sediment transport from the site by currents. Gravel, mineral, and oil mining occur in inshore environments which are essential for fisheries.

- Gravel / mineral mining is associated with an increase in stress to the surrounding habitat and the removal and disturbance of substrate. The alteration of the mining site can fragment habitat, negatively impacting fish and shellfish populations. Long-term mine sites can potentially change natural habitats and associated fish and shellfish populations (Wilk and Barr 1994).

- Oil mining has similar impacts as gravel / mineral mining but more risk is associated with spills and leakage from pipelines (i.e. blow-outs) which can disrupt habitat (Wilk and Barr 1994). Drilling muds and well cuttings are potential environmental concerns associated with operation of oil wells. Drilling muds (either water-based or oil-based muds) are complex and variable mixture of fluids, suspended solids, and chemical additives (Messieh et al. 1991).

- Deposits of peat are common in the watersheds of eastern Maine (USFWS 1995). Peat mining has the potential to remove riverine habitat and vegetation resulting in accelerated run-off, alteration of flow patterns, and the release of contaminants (i.e. peat fiber, arsenic residues, and other toxic chemicals).

Debris, either floating on the surface, suspended in the water column, covering the benthos, or along the shoreline, can have deleterious impacts on fish and shellfish within riverine habitat (see Coe and Rogers 1997). Debris is usually defined as man-made solid objects introduced into the environment (Hoagland and Kite-Powell 1997). Substrate and associated communities can be smothered or shaded by debris which results in alteration of the benthic community. Aquatic organisms may ingest pellets or plastic fragments or become entangled in rope or plastic strings which eventually kill the organisms. The natural processes of the environment are potentially disrupted by debris discharged into rivers and streams. Plastics account for nearly half of the marine debris found in Maine, New Hampshire, and Massachusetts. Metals, glass, and paper also constitute a proportion of debris in the three states. Cigarette butts are a potential problem in marine environments (Hoagland and Kite-Powell 1997). Major non-point sources of non-fishing related debris entering the marine environment include industrial shipping, recreational boating, municipal run-off, and decaying shoreline structures. Solid waste disposal, landfills, offshore mineral exploration, and industrial discharge are potential point sources of debris (USEPA 1994) (see Section 4.6 for fishing related debris).

Disposal of dredged material can disrupt and degrade natural habitat and biotic communities. The stresses associated with dredged material (i.e. oil, heavy metals, nutrients, suspended particles, etc.) potentially threaten the dump site and adjacent habitats. Along with contaminating the habitat, direct disturbance of the benthic and pelagic communities occurs with disposal. Benthic communities are smothered, associated physicochemical conditions are altered, and increased turbidity may hinder pelagic processes (e.g. photosynthesis of algae) by material settling to the bottom (see Section 5.3.1). The potential deleterious impacts of dredged material disposal can alter local and surrounding community structure.
Restoring or creating riverine habitat may include revegetation of banks and adding or cleaning gravel in streambeds. Considering these measures as ‘artificial reefs’ may be inappropriate, but for the purposes of this section artificial reefs will encompass these approaches. Artificial reefs can be an effective tool in fishery development with proper management (ASMFC 1993). Properly constructed artificial reefs potentially enhance rough bottom habitat and provide quality fishing grounds to the benefit of anglers and fishing communities (Stone 1982). The location and composition of artificial reefs in aquatic habitats should be assessed properly for the most effective methods to enhance fish and shellfish populations. Artificial reefs placed improperly may change natural habitat conditions, including sedimentation patterns and stream wandering. Also, community structure may be changed by attracting unnatural species assemblages.

5.4 THREATS TO INSHORE EFH

Inshore habitats have been impacted by decades of habitat destruction and degradation throughout the United States (NOAA 1994). Development of coastal lands for a suite of reasons has reduced habitat important to the spawning, breeding, feeding, and growth of finfish, shellfish, and aquatic vegetation. NOAA (1994) estimates that half of the original 11.7 million acres of coastal wetlands have been lost since 1780 and continue to be removed at a rate of 20,000 acres per year. The dynamic and productive nature of inshore habitats are threaten by point sources and non-point sources of contamination, and physical destruction. The flux of chemical, biological, and physical threats into inshore habitats impact fishery resources.

5.4.1 Chemical Threats

Oil (characterized as petroleum and any derivatives) may be a major stress on inshore fish habitats (see Wilk and Barr 1994 for review). Short-term impacts include interference with the reproduction, development, growth and behavior (e.g. spawning, feeding, etc.) of fishes, especially early life-history stages (see Gould et al. 1994 for review). Carcinogenic and mutagenic properties of oil compounds are receiving increasing attention around the world (Larsen 1992). Oil spills may cover and degrade coastal habitats and associated benthic communities, or may produce a slick on the surface waters which disrupts the pelagic community. Oil has been demonstrated to disrupt the growth of vegetation in estuarine habitats (Lin and Mendelssohn 1996). These impacts may eventually lead to disruption of community organization and dynamics in affected regions. Oil can persist in sediments for years after the initial contamination. This may cause problems to physiological and metabolic processes of demersal fishes (Vandermeulen and Mossman 1996). Non-point sources of oil are municipal and agricultural run-off, industrial shipping, recreational boating, and contaminated sediments. Point sources include power plant discharge, marine transportation (i.e. ferries, freighters, and tankers), energy and mineral exploration and transportation, and ocean disposal of contaminated dredged material.

Metal contaminants are found in the water column and persist in the sediments of coastal
habitats, including urban centers and fairly uninhabited regions, and are a potential environmental threats (Larsen 1992; Readman et al. 1993 Buchholtz ten Brink 1996). High levels of metals are found in the sediments of New England estuaries due to past industrial activity (Larsen 1992). Heavy metals may initially inhibit reproduction and development of marine organisms, but at high concentrations, they can directly or indirectly contaminate or kill fish and invertebrates. The early life-history stages of fish are the most susceptible to the toxic impacts associated with heavy metals (Gould et al. 1994). Shifts in phytoplankton species composition can occur. This shift in the plankton composition may lead to an alteration of community structure by replacing indigenous producers with species of little worth as a food source to the trophic structure. Heavy metals have also been implicated in disrupting endocrine secretions of marine organisms, potentially disrupting natural biotic properties (Brodeur et al. 1997). While long-term impacts do not appear notable in marine organisms, heavy metals may move upward through trophic levels and accumulate in fish at toxic levels (bioaccumulation), which can eventually cause health problems in human consumers. Municipal and agricultural run-off, contaminated groundwater and sediments, industrial shipping, recreational boating, and atmospheric deposition are non-point sources of heavy metals. Point sources include industrial discharge, power plants, ocean disposal of dredged material, and marine transportation [e.g. hull paint containing lead to hinder biofouling – tributyltin (the use of tributyltin has been banned in many regions but persists in the environment)].

Nutrients are essential for healthy ecosystems and control the productivity of the environment. However, nutrient over-enrichment can cause habitat degradation (ASMFC 1992; NOAA 1997). Eutrophication is a well documented impact involving nutrient over-enrichment occurring in coastal habitats (see O'Reilly 1994; Wilk and Barr 1994 for review). Habitats that become eutrophic are characterized by low dissolved oxygen (anoxia is possible), high turbidity, phytoplankton and filamentous algal blooms, and inhibited denitrification. Severely eutrophic conditions may reduce submerged aquatic vegetation (SAV) (Short and Burdick 1996; Goldsborough 1997), cause mass mortality of fish and invertebrates, and alter long-term natural community dynamics. Harmful algal blooms (HABs), commonly known as “red tides,” associated with unnatural nutrient levels have been known to stimulate fish disease and kills (see Section 5.4.2 for further discussion) (NSF and NOAA 1998). Excess nutrients within coastal waters originate from non-point sources such as municipal and agricultural run-off, contaminated groundwater and sediments, atmospheric deposition, septic systems, industrial shipping, recreational boating, wildlife feces, and nuisance and toxic algae (see Section 5.4.2). Point sources include industrial discharge, aquariums, sewage treatment plants, water diversion, ocean disposal of contaminated dredged material, silviculture, and energy and mineral exploration and transportation.

Pesticides found in coastal habitats have killed marine organisms, and they accumulate in sediments and can be re-released into the water column during substrate disturbance (e.g. channel dredging). Pesticides may bioaccumulate by being absorbed by sediments and detritus then ingested by zooplankton, plankters, which in turn are eaten by fish (e.g. Pleuronectiformes) (ASMFC 1992). Winter flounder (Pseudopleuronectes americanus) livers from Boston and Salem Harbors contain the highest concentrations of
dichlorodiphenyl trichloroethane (DDT) found on the east coast of the US and are ranked first and third, respectively, in the country in terms of total pesticides (Larsen 1992). This accumulation may cause health problems in humans consumers. Several pesticides are known to be endocrine disrupter of marine organisms. Agricultural run-off is a major non-point source, but pesticides can also occur at notable levels in residential areas. Other sources of pesticide discharge into coastal waters include atmospheric deposition and contaminated groundwater and sediments (non-point sources) and ocean disposal of dredged material and water diversion (point source) (see Meyers and Hendricks 1982 for review).

Herbicides may alter long-term natural community structure by hindering aquatic plant growth or destroying aquatic plants. Hindering plant growth can have notable effects on fish and invertebrate populations by limiting nursery and forage habitat. Chemicals used in herbicides may be endocrine disrupters. Coastal development and water diversion contribute substantial levels of herbicides entering fish and shellfish habitat. The major non-point sources are agricultural and municipal run-off, contaminated groundwater, and atmospheric deposition (Goldsborough 1997). Herbicides are also frequently used to inhibit colonization of boat hulls and pipes by micro-algae and subsequent growth of seaweeds (Readman et al. 1993).

Inshore regions can be impacted by the influx of acid. The brackish waters of estuaries are especially sensitive to acid effluents due to the lower buffering capacity of the higher salinity, oceanic waters. Acidification potentially disrupts or prevents reproduction, development and growth of fish (USFWS 1995). For example, osmoregulatory problems in Atlantic salmon smolts have been demonstrated to be related to habitats with low pH (Staurnes et al. 1996). Continual influx of acid to marine habitats can hinder the survival and sustainability of fisheries. Municipal and agricultural run-off, contaminated groundwater, and atmospheric deposition are potential non-point sources of acid influx to marine habitats. Industrial discharge and sewage treatment plant discharge are point sources of acid entering fish and shellfish habitat.

Chlorine can exert acute and sublethal effects on marine organisms (Sasikumar et al. 1993; Manning et al. 1996), especially early life history stages (Hose et al. 1989). The USEPA water quality criterion for chlorine discharge in marine and estuarine systems may not exceed 7.5 µg/L as a four day average and 13 µg/L as one-hour average more than once every three years (USEPA 1986). Chlorine effluent can decrease habitat quality and quantity leading to reduction of fishery resources. Chlorinated compounds [e.g. organochlorides – polychlorinated biphenyls (PCBs)], which can harm humans, have been found to accumulate in the tissue of fish (e.g. Pomatomidae) (Eldridge and Meaburn 1992). Long-term stress from chlorine on the habitat can alter natural community structure and dynamics. Compounds containing chlorine are often used to inhibit settlement of biofouling organisms (Sasikumar et al. 1993). Chlorine non-point sources include septic systems and contaminated groundwater, and point sources include discharge from sewage treatment plants, industrial facilities, and power plants.

Thermal effluents in inshore habitat can be a severe problem by directly altering the
benthic community or killing marine organisms, especially larval fish. Temperature influences biochemical processes of the environment and the behavior (e.g. migration) and physiology (e.g. metabolism) of marine organisms (Blaxter 1969). Long-term thermal discharge may change natural community dynamics. Sources of thermal pollution include industrial and power plant discharge. Forestry activities such as clear-cutting and the alteration or removal of riparian habitat can also lead to above normal water temperatures contributing to the degradation of habitat conditions.

Metabolic and/or excess food entering the marine environment can increase levels of nutrients and pathogens and lead to eutrophication and alteration of local benthic dynamics. A major source of metabolic and food wastes is agricultural facilities. Runoff from farmlands, including animal wastes and organic fertilizers, may contribute to the degradation of habitat. Septic systems, wildlife feces, and nuisance / toxic algae (non-point source), livestock waste and sewage treatment plants (point sources) are other sources of organic wastes potentially impacting habitat.

Fish and invertebrate habitat may be negatively impacted by an unnatural influx of suspended particles (Arruda et al. 1983). Lethal and sub-lethal impacts to marine organisms may occur with various concentrations of suspended sediments (Barr 1993). Short-term impacts of an increase in suspended particles include high turbidity, reduced light, and sedimentation which may lead to the loss of SAV and other benthic structure. Other problems associated with suspended solids include respiration disruption of fishes and invertebrates, disruption of water transport rates in marine organisms, reduction of filtering efficiency of invertebrates, sorption of metals and organic materials, reduction of egg buoyancy, disruption of ichthyoplankton development, reduction of growth and survival of filter feeders, and decreased foraging efficiency of sight-feeders (Messieh et al. 1991; Barr 1993). Toxic metals and organics absorbed by suspended solids may recur and become more available to marine organisms in the habitat when disturbed (e.g. dredging). Resuspension of sediments may supply nutrients to the water column that are needed for primary production. However, increased flux of nutrients into the water column may stimulate phytoplankton production and contribute to increased turbidity and alteration of nutrient cycles. Frequent high levels of suspended particles can lead to the loss of habitat for particular creatures. Suspended particles enter coastal areas from non-point source municipal and agricultural run-off, industrial shipping and recreational boating, and point source industrial discharge (e.g. pulp mills), dredging, ocean disposal of dredged material, water diversion, energy and mineral exploration and transportation, erosion control, silviculture, and marine transportation.

Radioactive wastes may be a potential threat degrading inshore habitat used by finfish and shellfish species. Fishery resources may accumulate radioactive isotopes in tissues posing problems for the resource and consumers (ICES 1991). Long-term exposure to radioactive wastes may alter the natural dynamics of the populations of fisheries and habitat. Potential sources of radioactive wastes are sunken vessels and submarines, municipal run-off, atmospheric deposition, contaminated groundwater and sediments (e.g. past dumping locations), and industrial and power plant discharge (e.g. nuclear power plants).
Sea levels have fluctuated through the history of earth and have been rising since the end of the Pleistocene. Changes in the rate of sea level rise result from tectonic and postglacial isostatic adjustments and effects of atmospheric temperature (Valiela 1995). Concern has been voiced that global warming and subsequent sea level rise may be accelerated by the continued release of greenhouse gases from the burning of fossil fuels and forests and using aerosol-producing substances (i.e. the greenhouse effect). Greenhouse gases, including carbon dioxide, methane, and chlorofluorocarbons, are discharged into the atmosphere from respiration of all living organisms, burning fossil fuels and forests, and using aerosols. Possible impacts on inshore habitats from sea level rise are the loss of wetlands, salinization of freshwater environments (eliminating freshwater supplies), and change in natural marine biotic (e.g. species composition) and abiotic (e.g. currents) properties (see Kelley 1992 for review). Salt marshes may be unable to accrete fast enough to keep pace with sea level rise; however, salt marshes can easily keep pace with the sea level rise found on the northeast coast of the United States (Valiela 1995) provided uplands are undeveloped adjacent to the salt marsh. Conflicting studies indicate that salt marshes of Maine are not keeping pace with sea level rise (Wood et al. 1989). According to Bigford (1991), the severity of the impacts of sea level rise on natural resources (e.g. marine organisms) depends on physical obstruction to inland habitat shifts from natural and human barriers, resilience of species to withstand new environmental conditions during periods of erosion-induced transition and the rate of environmental change.

5.4.2 Biological Threats

The introduction of nonindigenous species and/or reared species to the environment has been documented (Rosecchi et al. 1993; USFWS 1995; Witman 1996) and have been tied closely to human activities (Pearce 1998). Exotic introductions have apparently increased with the development of large, powerful vessels and aquaculture. The transportation of nonindigenous organisms to new environments can have many severe impacts on habitat (Omori et al. 1994). New pathogens or higher concentrations of disease can be spread throughout the environment resulting in deleterious habitat conditions. Non-native plants (e.g. Phragmites) potentially degrade coastal habitat by changing natural habitat qualities. Introduced organisms increase competition with indigenous species or forage on indigenous species which can reduce fish and shellfish populations. For example, the introduction of bryozoan (Membranipora membranacea) has reduced kelp populations, ascidian (Botrylloides diegensis) has competitively displaced native hydroids, nudibranch (Tritonia plebia) has reduced invertebrate prey populations, and macroalgae (Codium fragile) has changed benthic structure (see Witman 1996). Long-term impacts of the introduction of nonindigenous and reared species can change the natural community structure and dynamics, lower the overall fitness and genetic diversity of natural stocks, and pass and/or introduce exotic lethal disease. Exotic fish, shellfish, pathogens, and plants enter the environment from industrial shipping (e.g. ballast), recreational boating, aquaculture (addressed in Section 4.7), biotechnology, and aquariums. Nonindigenous species of algae accidentally introduced to the environment is another potential problem for habitat (expanded below).
An increase in natural levels of nutrients induced by human activities can stimulate population explosions of nuisance and toxic algae [harmful algal blooms (HABs)] which have detrimental impacts to habitat and toxic effects on organisms and humans (see Milligan and Cosper 1994; O’Reilly 1994; Boesch et al. 1997; Burkholder and Glasgow 1997). Organisms responsible for HABs have naturally occurred in the environment for a long time, so the apparent increase bloom events may simply reflect better detection of natural phenomena (NSF and NOAA 1998). However, the current increased intensity and frequency of HABs compared to the past appears to indicate more toxic algal species, more algal toxins, more areas affected, more fishery resources affected, and higher economic losses (Boesch et al. 1997; NSF and NOAA 1998). Blooms of HABs have been nearly an annual event in coastal waters of New England for several years (White et al. 1993). Nonindigenous algal species may be introduced to the environment from ballast water of commercial vessels, recreational boating, shellfish transfer (e.g. seeding), dredging, and disposal of sediments (Boesch et al. 1997), adding to the potential problem of blooms. HAB-related events have occurred around the entire coast of the United States. HABs can indicate eutrophic conditions, alter, impair, or kill plankton and fish communities, smother indigenous vegetation, and lower dissolved oxygen (NOAA 1997). Certain toxic organisms (e.g. *Pfiesteria* spp.) are associated with HABs and have caused major outbreaks of disease and fish kills (Burkholder et al. 1992; NCSU 1998). These short-term impacts can eventually change the natural processes of habitat, reducing viable fish and shellfish populations.

The spread of disease among marine organisms is a potential adverse impact to fish habitat in coastal regions. Pathogens introduced inadvertently (e.g. via run-off) or advertently (e.g. from restocking programs) may spread infections which can be sublethal or lethal and possibly decrease the health and fitness of fish stocks (Kent et al. 1995). Human influences (e.g. nutrient over-enrichment) also have been illustrated to stimulate blooms of naturally occurring pathogens (NCSU 1998). The toxic dinoflagellate, *Pfiesteria piscicida* and other species, has been implicated as the primary causative agent of many fish kills and disease episodes in estuaries and inshore areas (Burkholder et al. 1992; NCSU 1998). Mortality and gill lesions in Atlantic salmon were associated with a bloom of *Skeletonema costatum* and *T. rotula* (Kent et al. 1995). Shellfish area closures have resulted from the infestation of diseases (i.e. paralytic, amnesic, and neurotoxic shellfish poisoning) caused by pathogens (i.e. *Alexandrium*, *Pseudo-nitzchia*, *Gymnodinium breve* respectively), but the toxins also move up through the trophic web, affecting zooplankton, fish eggs and larvae, juvenile and adult fish, birds, and marine mammals (Boesch et al. 1997). Direct sources of pathogens entering the environment include non-point sources such as municipal and agricultural run-off, septic systems, wildlife feces, industrial shipping, and recreational boating, and point sources such as disposal of dredged material, biotechnology labs, aquariums, and sewage treatment (ASMFC 1992).

### 5.4.3 Physical Threats

Channel dredging is a frequent long-term maintenance activity associated with coastal development, port and harbor development, and vessel activity (see Barr 1987 for review). The increased need for channel dredging has resulted from increased marine
transportation, increased vessel size, expansion of commercial fleets, and alterations in sedimentation patterns of estuaries due to increased coastal settlement and urbanization (Messieh et al. 1991). The short-term impacts to habitat can be substantial. Dredging resuspends sediments (see Section 5.4.1) and associated contaminants and potentially degrades habitat quality and fish populations. Changes in tidal prism, depth, water temperature, salinity, water velocity, bottom topography, and sediment type are associated with dredging of channels. The changes can decrease dissolved oxygen and SAV distribution and density while smothering the surrounding benthic community. The reconfiguration of sediment type and the removal of biogenic structure may decrease the stability of the bottom and increase the ambient turbidity levels (Messieh et al. 1991). The dredged channel can increase the transport of sediment and siltation rates in the embayment resulting in alteration of local habitats. Increased siltation can effect spawning, feeding, and recruitment habitat (Messieh et al. 1991). Fragmentation of habitat can hinder the movements (i.e. dispersal, recruitment, migrations, etc.) of organisms. The continual maintenance involved with channel dredging can eventually change the indigenous habitat and population dynamics of the region.

The dredging and filling of wetlands for shoreline, coastal, port, and harbor development removes and alters habitat surrounding the developed area. Dredge and fill reduces the wetland function (i.e. retain floodwater and uptake nutrients) and decreases the amount of detrital food source available to biotic communities. Hydrological modifications from dredge and fill activities and general coastal development (e.g. golf courses) may increase the amount of run-off entering the coastal environments that may contribute to the degradation of fishery resources. Along with these specific impacts of wetland dredge and fill activities, the short- and long-term impacts are similar to channel dredging.

Marina and dock construction is an inevitable result of shoreline and port development. Regions that ports are constructed usually contain important estuarine habitats such as salt marshes and grass flats. The development of ports and harbors usually removes or alters these important habitat features (Vandermeulen 1996). The construction of marinas and docks also aggregates contaminants associated with the vessels that use the facilities. Along with contamination of the habitat, the construction of marinas changes habitat parameters such as tidal prism, depth, water temperature, salinity, current velocity and SAV composition, distribution, and abundance. SAV is removed during construction and shaded by the physical structures after construction eventually destroying the vegetation. Mooring chains are frequently used in embayments surrounding marinas and docks. Mooring chains potentially degrade habitat conditions through physical disturbance of benthic features (e.g. SAV). Repeated small-scale habitat loss can have cumulative effects and can fragment habitat which can have a detrimental impact on fish and shellfish stocks. The long-term presence of marinas can contaminate the localized area and change natural habitat qualities and population dynamics in the region. Channel dredging and its associated threats (see Section 5.3.3) is directly related to the development of ports and harbors.

Vessel activity, including industrial shipping, recreational boating, and marine transportation (e.g. ferry transportation), may contribute to the physical degradation of
marine habitats and related marine organisms. Increased vessel activity within coastal waters is directly related to increase in coastal urbanization and port and harbor development. There is generally a paucity of information of boating use levels, but there has been increasingly more boats using coastal waters for the last two decades (Stolpe 1996). For example, the Gulf of Maine is one of the busiest fishing ports on the east coast and is the third largest oil port in the east (Larsen 1992). Recreational boating may also be a particular concern since most boating activity occurs in warmer months – the time of greatest biological activities in east coast estuaries (Stolpe 1996). The severity of boating-induced disruption on coastal habitats may depend on the geomorphology of the impacted area (i.e. water depth, width of channel or tidal creek, etc.), current speed, composition of sediments, vegetation type and extent of cover, and classification of boat traffic (Yousef 1974; Karaki and vanHoften 1975; Barr 1993). The benthos, shoreline, and pelagic habitat may be disturbed or altered from vessel use in inshore regions, and may result in a cascade of cumulative impacts from hundreds of trips per day in heavily used areas (Barr 1993).

- The direct disturbance of bottom topography (e.g. prop scarring) results in increased turbidity (see Section 5.4.1 for further details) which can lead to the direct loss of SAV, nursery and forage habitat that may adversely affect benthic recruitment, or re-release nutrients into the water column and increase primary productivity that may indirectly reduce SAV through decreasing the depth of light penetration (Yousef 1974; Hilton and Phillips 1982; Barr 1993; Stolpe 1996). Disturbance of nutrient-rich surficial sediments by vessels may indirectly contribute to nutrient over-enrichment of inshore habitats (Barr 1993). Other environmental conditions (i.e. water temperature, dissolved oxygen, pH, etc.) may also change with the resuspension of bottom sediments (Barr 1993). The destruction of SAV and other benthic habitat (i.e. sponge colonies) may consequently fragment, decrease quality, and/or destroy large areas of habitat.

- Elevated wakes caused by industrial and recreational shipping and transportation can have substantial impacts on coastal habitat. The continual disturbance of water along frequently traveled routes can lead to shore erosion, substrate disturbance, increase turbidity, and pelagic disturbance (Barr 1993; Stolpe 1992) which can eventually cause the loss of habitat.

- The water column, especially the pelagic and neritic communities, is critical for the survival and health of fish and shellfish stocks. The propeller or impeller of vessels may directly damage or kill ichthyoplankton or other creatures in the upper water column (Stolpe 1992; Stolpe 1996), or indirectly damage important creatures (i.e. diatoms and other microflora) by increasing turbidity in the water column (Barr 1993). It was also suggested that the noise and direct disturbance to the neritic zone may be notable factors in disturbing the migration or recruitment of coastal organisms (Barr 1993; Stolpe 1996). Continued disturbance of these particular pelagic habitats that fishes aggregate can result in decreases of numbers of marine organisms.
As more people move to the coast, development pressure increases and structures are often constructed along the coastline to prevent erosion and stabilize shorelines. Attempts to protect beaches and reduce shoreline erosion are associated with the development of the coast. Bulkheads, seawalls, jetties, and groins are structures designed to slow or stop the shoreline from eroding. In many cases the opposite occurs with erosion rates increasing along the regulated area. Adjacent coastal habitat is altered and potential short- and long-term impacts to fish and shellfish stocks are associated with the presence of the erosion control structures.

- **Bulkheads** are rigid structures built parallel to the shoreline (Leatherman 1988) of bays and can alter habitat by changing the wave energy dynamics along the coast which can increase erosion and eliminate the land-water interface. The change in wave energy dynamics alters sedimentation patterns which can disrupt benthic structure (e.g. SAV). The long-term presence of bulkheads can lead to severe erosion along the shoreline and change the natural habitat and associated biotic dynamics of the region.

- **Seawalls** are very similar to bulkheads, but are built along the coast of the open ocean for erosion protection. Seawalls change the wave energy dynamics along the shore which prevents natural sediment exchange. They can quickly erode the shore, eliminate the land-water interface, and potentially remove the benthic community. Disruption of littoral drift and the associated patterns of egg and larval dispersal occurs with the construction of seawalls along the coast. Potential long-term impacts to habitat are erosion of the shore and subsequent changes to natural habitat and dynamics.

- **Jetties** are paired structures constructed perpendicular to the shore at the mouth of a channel, often used to reduce the filling of channels with sediments to protect and maintain navigable inlets (Leatherman 1988). The construction of jetties can have deleterious impacts on coastal habitats. Longshore transport of sediment is trapped on the updrift side of the jetty, and the beaches downdrift erode with no accretion to replace sediments. The change in sedimentation, tidal, and current patterns can alter the movement of eggs and larvae which depend on natural patterns of dispersal for survival. The natural habitat and population dynamics are potentially changed with the presence of jetties.

- **Groins** are a series of small jetties constructed perpendicular to the shore which extend from the beach into the surf zone (Leatherman 1988) and are a potential source of erosion control. The impacts to habitat are less severe than jetties and equilibrium of sediment transport may occur along the coast. The long-term impacts of groins appear to be low, but potential problems should not be ignored.

Development of the shoreline may include structures which restrict tidal movements (i.e. roads, bridges, dikes, etc.). The natural flushing of estuarine habitats (e.g. salt marshes) can be hindered by the construction of tidal restricting structures. Confined inshore waters with restricted water exchange may allow HABs to persist (Boesch et al. 1997).
Physicochemical properties (i.e. salinity, dissolved oxygen, flow, etc.) are altered changing the habitat characteristics that may hinder migratory, spawning, feeding and dispersal movements of marine organisms resulting in depleted stocks of fish and invertebrate species. The hindrance or blockage of tidal flushing and associated biotic movements can degrade associated habitat by altering the natural dynamics.

Dam construction and operation occurs along the New England coast for flood control, power generation, and reservoir formation. The construction of dams with either inefficient or non-existent fish ways was a major cause of the population decline of U.S. Atlantic salmon, Salmo salar (USFWS 1995). Dams alter water flow and sedimentation patterns, depth, water temperature, salinity and stream bed properties. Estuaries directly lose freshwater input with the construction of dams. Migration of fishes is hindered or blocked. Fishes are impinged and entrained, and exposed to dissolved gas supersaturation, aggregated contaminants, and high concentrations of predators and disease in the habitat surrounding dams. The disruption of fish development because of riverine dam construction can directly change the natural habitat and fishery dynamics of inshore regions. The loss of wetlands by the reduction of freshwater input and sediments can have potentially serious impacts on both fish and invertebrate populations.

Freshwater flows into inshore environments are subject to human alteration through water diversion and use and modifications to the watershed (i.e. deforestation, tidal restrictions, and stream channelization) (Boesch et al. 1997). Water withdrawal for freshwater drinking supply, power plant coolant systems, and irrigation occurs along urban and agricultural coasts causing potential detrimental effects on marine habitats and is associated with coastal development. The mass flow of water into a power plant and other reservoirs results in entrainment and impingement of fishes (especially early life-history stages of fish). Larval and juvenile demersal fishes along with invertebrates are susceptible to entrainment and impingement around intake pipes (ASMFC 1992). Critical habitat is lost for marine organisms that are not capable of settling around the intake and may adversely affect fish and shellfish populations by adding another source of mortality to the early life stage which often determines recruitment and strength of the year-class (Travnichek et al. 1993). Water withdrawal and diversion along with anthropogenic watershed changes have been related to the increase in some HABs (Boesch et al. 1997) impacting aquatic and marine habitat. The continued diversion and use of water from coastal waters can lead to degradation of fish and shellfish habitats.

- Freshwater is becoming limited because of natural events (e.g. droughts), increasing demand of potable water, and inefficient use. Fresh and saline water is withdrawn for human use from the estuarine and coastal environments. The withdrawal of water can alter natural current patterns, water temperature, salinity, tidal prisms, and associated biotic communities.

- Irrigation for agriculture alters currents, salinity, water temperature, depth and drainage and sedimentation patterns of estuarine and marine habitat along the coast. Sedimentation within estuaries can hinder benthic processes and communities. Irrigation can also increase run-off containing materials (i.e. heavy
metals, nutrients, etc.) which stress the habitat. The changes to the natural habitat caused by irrigation can potentially lead to changes in the dynamics of marine organisms.

Inshore habitats are impacted by deforestation. Silviculture practices and coastal development contribute to the removal of vegetation and subsequently an increase of impervious surfaces along a river which increases stream bank and stream bed erosion and sedimentation of riparian and estuarine habitat. Hydrologic characteristics (e.g. water temperature) are changed and greater variation in stream discharge is associated with the forestry industry (USFWS 1995). Debris (i.e. wood and silt) are released into the water as a result of the harvest of the forest which can smother benthic habitat. Deforestation can alter or impair natural habitat structures and dynamics.

There is an increasing demand for good-quality sand and gravel aggregate and an increasing exploration for oil, and offshore habitats are being seen as a possible source (Messieh et al. 1991). Mining presents potential direct and indirect problems within inshore habitats such as issues related to toxicity of operational chemicals, accidental discharge of wastes, removal of benthic flora and fauna, changes in substrate character, and the suspension of sediments (ICES 1991). Mining can have direct and indirect impacts to the habitat of the mining site and surrounding regions. Structures are built within habitats to assist in mining and transporting materials. In a review by Pearce (1994), the effects of mining have been listed as: (1) “destruction” of existing benthic biotic community; (2) resuspension of sediments with negative impacts on fishes (see Section 5.4.1); (3) changes in bottom topography and sediment composition; and (4) consequences related to the sediment transport from the site by currents. Gravel, mineral, and oil mining occur in inshore environments which are essential for fisheries, and operational and accidental discharges are an environmental concern (Messieh et al. 1991).

- Gravel aggregates are abundant throughout the Gulf of Maine and are a potential source for miners (Messieh et al. 1991). Removal of sand from inshore habitats may increase coastal wave action and erosion as a result of the removal of source material for the maintenance of barrier islands and beaches (Messieh et al. 1991). Gravel / mineral mining is associated with an increase in stress to the surrounding habitat and removal and disturbance of substrate (Scarrat 1987). The alteration of the mining site can fragment habitat, negatively impacting fish and shellfish populations. Long-term mine sites potentially can change natural habitats and associated fish and shellfish populations (Wilk and Barr 1994).

- Oil mining has similar impacts as gravel / mineral mining but more risk is associated with spills and blow-outs (i.e. ruptured pipelines) which can disrupt habitat (Wilk and Barr 1994). Oil wells are in the initial stage of exploration, and drilling muds and well cuttings are potential environmental concerns. Drilling muds (either water-based or oil-based muds) are complex and variable mixture of fluids, suspended solids, and chemical additives (Messieh et al. 1991).
Debris, either floating on the surface, suspended in the water column, covering the benthos, or along the shoreline within inshore habitat can have deleterious impacts on fish and shellfish habitat (see Coe and Rogers 1997). Debris is usually defined as man-made solid objects introduced into the environment (Hoagland and Kite-Powell 1997). Benthic communities can be smothered or shaded by debris which results in alteration of the benthic community. Marine organisms may ingest pellets or plastic fragments or become entangled in rope or plastic strings which eventually kill the organisms. The natural processes of the environment are potentially disrupted by debris discharged into inshore habitats. Hoagland and Kite-Powell (1997) review the type, sources, and fates of marine debris in the Gulf of Maine. Plastics account for nearly half of the marine debris found in Maine, New Hampshire, and Massachusetts. Metals, glass, and paper also constitute a proportion of debris in the three states. Cigarette butts are a potential problem in marine environments. Major non-point sources of non-fishing related debris entering the marine environment include industrial shipping, recreational boating, municipal run-off, and decaying shoreline structures. Solid waste disposal, landfills, offshore mineral exploration, and industrial discharge are potential point sources of debris (USEPA 1994) (see Section 4.6 for fishing related marine debris).

Disposal of dredged material can disrupt and degrade natural habitat and biotic communities. The stresses associated with dredged material (i.e. oil, heavy metals, nutrients, suspended particles etc.) can threaten the habitat of the dump site and adjacent areas. Along with contaminating the habitat, direct disturbance of the benthic and pelagic communities occurs with disposal. Benthic communities are smothered, associated physicochemical conditions are altered, and increased turbidity may hinder pelagic processes (e.g. photosynthesis of algae) by material settling to the bottom (see Section 5.4.1). The potential deleterious impacts of dredged material disposal can alter local and surrounding community structure.

Artificial reefs can be an effective tool in fishery development with proper management (McGurrin et al. 1989; ASMFC 1993). Properly constructed artificial reefs can enhance rough bottom habitat and provide quality fishing grounds to the benefit of anglers and coastal communities (Stone 1982). The location and composition of artificial reefs in inshore waters should be assessed properly for the most effective methods to enhance fish and shellfish populations. Artificial reefs placed improperly may change natural habitat conditions and community structure by attracting unnatural species assemblages. Inappropriate reef material (i.e. combustion/incineration ash and tires) may decompose and release toxic substances to the surrounding area, and reefs may become dislodged from the bottom and disrupt benthic structure.

5.5 Threats to Offshore EFH

Habitats within the offshore region of New England are found, generally, in deep waters with stable biological communities. There are also many high energy offshore habitats in which environmental conditions are continuously changing. Benthic and pelagic marine life are disrupted by a growing number of threats within offshore waters. As threats are continually added to inshore waters, contamination migrates away from the coast and
potentially endangers the health of offshore habitats. Offshore waters are being looked to more frequently to supply new resources or resources that have been eliminated from coastal environments. Deep, stable waters and high energy offshore habitats may be disturbed by the increasingly amount of non-fishing threats and may disrupt environmental conditions. Low levels of disturbance in deep, stable habitats may present serious implications on finfish and shellfish populations. Disruptions in more stable environments also presents concern for marine ecosystems. Chemical, biological, and physical threats continue to grow in areas important for fishery resources in the offshore region.

5.5.1 Chemical Threats

Oil can have severe detrimental impacts on offshore habitat. Spills or blowouts can produce an oil slick on surface waters which can disrupt the entire pelagic community (i.e. phytoplankton, zooplankton, ichthyoplankton). The contaminant can interfere with reproduction, development, growth and behavior (e.g. feeding) of fishes, especially in early ontogenetic stages. Carcinogenic and mutagenic properties of oil compounds are receiving increasing attention around the world (Larsen 1992). Oil slicks may not persist in surface waters of the offshore for a long period; however, if repeated spills or blowouts associated with wells or transport persist, the community organization and dynamics may be disrupted. Oil will accumulate and persist in sediments. Contaminated sediments may degrade benthic communities. Non-point and point sources of oil in offshore habitats originate from industrial shipping, recreational boating, marine transportation, energy and mineral exploration and transportation, and ocean disposal of contaminated dredged material.

Marine organisms can be contaminated or killed directly and indirectly from the stress of heavy metals discharged into offshore waters. Sediment accumulates the toxic metals, and fishes bioaccumulate contaminants which can cause health problems in human consumers of fish. Industrial and recreational shipping and atmospheric deposition are non-point sources of heavy metals. Ocean disposal of contaminated dredged material, energy and mineral exploration (e.g. drilling muds), and marine transportation (e.g. hull paint containing lead) introduce heavy metals into the environment (Larsen 1992; Buchholtz ten Brink 1996).

Localized eutrophic conditions, characterized by phytoplankton and filamentous algal blooms (HABs), high turbidity, low dissolved oxygen, and low denitrification rates, can occur in offshore habitats with unnaturally high concentrations of nutrients. Any increase in the nutrient levels of the open ocean will markedly effect the productivity of phytoplankton communities (Omori et al. 1994). Increasing the surface productivity may increase the flux of material from the sea surface to the deep sea benthos (Omori et al. 1994). The stable, deep sea environment is trophically linked to the surface waters and an increase flux of organic matter may have notable impacts on bottom habitats (Omori et al. 1994). Other toxic organisms may be implicated with the blooms of noxious algae causing outbreaks of disease or fish kills (see Section 5.5.2). Long-term impact of persistent eutrophication in offshore habitats can cause mass mortality of marine organisms and alter natural community dynamics. Nutrients enter offshore waters from
non-point sources such as industrial shipping, recreational boating, and atmospheric deposition, and point sources, including ocean disposal of contaminated dredged material, and energy and mineral exploration and transportation.

Fish and invertebrate populations may be impacted by the input of pesticides into offshore habitats. Marine organisms may be directly killed by pesticides or bioaccumulation may occur with long-term exposure. Contaminated sediments can accumulate in the benthos providing a potential source of stress through trophic levels. Pesticides enter offshore habitats through atmospheric deposition illustrating a potential non-point source, and ocean disposal of dredged material illustrating a point source.

Herbicides and fungicides can alter marine habitats by hindering phytoplankton growth and possibly leading to lasting community structure change. Alteration of the photosynthetic plankton community can alter fishery dynamics by replacing natural plankton species composition with new species. The change in the planktonic community may change the lower trophic structure so cascade effects may hinder fish populations (e.g. bottom-up process). Herbicides can be released into offshore habitats from atmospheric deposition and disposal of dredged material.

Unnatural levels of suspended particles in offshore habitats can increase turbidity, smother benthic habitat, hinder respiration, disrupt water transport rates, and reduce filtering efficiency of organisms. Other problems associated with suspended solids include sorption of toxic metals and organic materials, reduction of egg buoyancy, disruption of ichthyoplankton development, reduction of growth and survival of filter feeders, and decreased foraging efficiency of sight-feeders (Barr 1993). The functions (e.g. photosynthesis) and properties (e.g. dissolved oxygen) of the entire water column may be frequently disrupted. Long-term flux of suspended sediments to offshore waters may provide a source of nutrients that stimulate primary production and contribute to increased turbidity and altered nutrient cycles. Continued high levels of suspended material within offshore waters can lead to fragmentation and alteration of localized community of benthic and pelagic organisms. Suspended particles enter the offshore environment from ocean disposal of dredged material and mining practices.

- Radioactive wastes (see Section 5.4.1).
- Greenhouse gases (see Section 5.4.1).

5.5.2 Biological Threats

Nonindigenous species and reared species potentially impact natural populations by transmitting diseases (exotic or natural), increasing competition with indigenous species, increasing predation on natural organisms, and altering the natural genetic pool (e.g. less genetic heterogeneity). These deleterious impacts can potentially lead to lower fitness of stocks and change the natural community structure and dynamics. Human activities are closely associated with exotic introductions. Shipping (e.g. ballast water), aquariums, and biotechnology are potential sources of nonindigenous species in offshore waters.
Dredged material disposal may introduce algal species that degrade habitat conditions.

An increase in natural levels of nutrients induced by human activities can stimulate population explosions of nuisance and toxic algae [harmful algal blooms (HABs)] which have detrimental impacts to habitat and toxic effects on organisms and humans (see O’Reilly 1994; Boesch et al. 1997). Organisms responsible for HABs have naturally occurred in the environment for a long time, so an apparent increase in bloom events may simply reflect better detection of natural phenomena (NSF and NOAA 1998). However, the current increased intensity and frequency of HABs compared to the past appears to indicate more toxic algal species, more algal toxins, more areas affected, more fishery resources affected, and higher economic losses (Boesch et al. 1997; NSF and NOAA 1998). Nonindigenous algal species may be introduced to the environment from ballast water of commercial vessels, recreational boating, shellfish transfer (e.g. seeding), dredging, and disposal of sediments (Boesch et al. 1997), adding to the potential problem of blooms. HABs can indicate eutrophic conditions, alter, impair, or kill plankton and fish communities, and lower dissolved oxygen (NOAA 1997). Certain toxic organisms (e.g. Pfiesteria spp.) are associated with HABs and have caused major outbreaks of disease and fish kills within inshore waters (NCSU 1998); however, these outbreaks may spread to offshore habitats. These short-term impacts can eventually cause a change in the natural processes of habitat reducing viable fish and shellfish populations.

Pathogens can be a serious problem in offshore waters by spreading disease and possibly impacting the long-term success, health, and fitness of fish and invertebrate populations. Shellfish area closures may be required as a result of the spread of diseases (i.e. paralytic, amnesic, and neurotoxic shellfish poisoning) which have impacts on human health. For example, paralytic shellfish toxins have been detected in Atlantic surfclams (Spisula solidissima), Atlantic sea scallops (Placopecten magellanicus), northern horse mussels (Modilus modiolus), and ocean quahogs (Arctica islandica) within areas of Georges Bank at levels exceeding the public health safety threshold (White et al. 1993). Potential origins for pathogens in the environment include non-point sources of discharge such as industrial shipping, recreational boating, and point sources of discharges such as aquariums and biotechnology (NOAA 1992). Localized regions of high nutrients may trigger outbreaks in harmful organisms that may hinder the health and success of fish and shellfish populations.

5.5.3 Physical Threats

Vessel activity, including industrial and recreational shipping and ferry transportation, may contribute to the physical degradation of marine environments and associated organisms. Marine organisms may be directly injured or killed by the propeller or impeller of vessels (Stolpe 1996). Frequently traveled ferry routes within offshore waters may slightly disturb pelagic habitat which can potentially disrupt spawning behavior, recruitment patterns, and egg and larval transport (Barr 1993). The continual disturbance of the pelagic habitat may potentially hinder long-term productivity of offshore waters.

There is an increasing demand for good-quality sand and gravel aggregate and an increasing exploration for oil, and offshore habitats are being seen as a possible source (Messieh et al. 1991). For example, Georges Bank is being proposed for several
exploratory drillings because of its hydrocarbon potential (Messieh et al. 1991). Mining presents potential direct and indirect problems to habitat of the mining site and surrounding regions such as issues related to toxicity of operational chemicals, accidental discharge of wastes, removal of benthic flora and fauna, changes in substrate character, and the suspension of sediments (ICES 1991). Structures are also built within habitats to assist in mining and transporting materials. In a review by Pearce (1994), the effects of mining have been listed as: (1) “destruction” of existing benthic biotic community; (2) resuspension of sediments with negative impacts on fishes (see Section 5.5.1); (3) changes in bottom topography and sediment composition; and (4) consequences related to the sediment transport from the site by currents. Gravel, mineral, and oil mining occur in marine environments which are essential for fisheries, and operational and accidental discharges are an environmental concern (Messieh et al. 1991).

- Gravel aggregates are abundant throughout the Gulf of Maine and are a potential source for miners (Messieh et al. 1991). Gravel / mineral mining is associated with an increase in stress to the surrounding habitat and removal and disturbance of substrate (Scarrat 1987). The alteration to the mining site can fragment habitat, negatively impacting fish and shellfish populations. Long-term mining sites potentially can change natural habitats and associated fish and shellfish populations (Wilk and Barr 1994).

- Oil mining has similar impacts as gravel / mineral mining with more risk associated with accidental spills and blow-outs which can disrupt habitat (Wilk and Barr 1994). Oil wells are in the initial stage of exploration in offshore New England waters. Drilling muds and well cuttings are potential drilling wastes of oil exploration. Drilling muds (either water-based or oil-based muds) are complex and variable mixture of fluids, suspended solids, and chemical additives (Messieh et al. 1991). If exploration results in notable amounts of resources, industrial development may occur in offshore waters; consequently, leading to larger amounts of drilling wastes and discharge (Messieh et al. 1991).

Debris discharged or transported offshore may degrade and disrupt benthic and pelagic habitats (see Coe and Rogers 1997). Debris within offshore habitat can smother benthic communities or be ingested by fish (Hoagland and Kite-Powell 1997). Reduction of habitat by destroying the benthos can alter community structure and hinder the sustainability of fisheries. Debris non-point sources include industrial shipping and recreational boating, and a point source includes ocean disposal of garbage and mineral exploration (USEPA 1994) (see section 4.6 for fishing related marine debris).

Disposal of dredged material can disrupt and degrade natural habitat and biotic communities. The associated stresses of dredged material (i.e. oil, heavy metals, nutrients, suspended particles etc.) potentially threaten the habitat of the dump site and adjacent areas. Providing a flux of nutrients to offshore habitats from dredged material may be a notable source contributing to algal blooms. Along with contaminating the habitat, direct disturbance of the benthic and pelagic communities occurs with disposal. Benthic communities are smothered, associated physicochemical conditions are altered,
and increased turbidity may hinder pelagic processes (e.g. photosynthesis of algae) by material settling to the bottom (see Section 5.5.1). The potential deleterious impacts of dredged material disposal can alter local and surrounding community structure.

Artificial reefs can be an effective tool in fishery development with proper management (McGurrin et al. 1989; ASMFC 1993). Properly constructed artificial reefs can enhance rough bottom habitat and provide quality fishing grounds to the benefit of anglers and offshore fisheries (Stone 1982). The location and composition of artificial reefs should be assessed properly for the most effective methods to enhance fish and shellfish populations. Artificial reefs placed improperly may change natural habitat conditions and community structure by attracting unnatural species assemblages. Inappropriate reef material (i.e. combustion/incineration ash and tires) may decompose and release toxic substances to the surrounding area, and reefs may become dislodged from the bottom and disrupt benthic structure.

5.6 SPECIFIC EXAMPLES OF POTENTIAL NON-FISHING THREATS

Coastal development has been previously noted as a major contributor to the alteration and degradation of aquatic and marine habitats. The New England coast is lined with numerous urban centers and associated harbors and ports (Table 12). Potential habitat loss or change is greater in areas of high population density.

Table 12: The major ports and harbors within the New England region. List compiled from NOAA 1996.

<table>
<thead>
<tr>
<th>PRIMARY PORTS</th>
<th>SECONDARY PORTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland, ME</td>
<td>Boothbay, ME</td>
</tr>
<tr>
<td>Boston, MA</td>
<td>Bucksport, ME</td>
</tr>
<tr>
<td>Gloucester, MA</td>
<td>Eastport, ME</td>
</tr>
<tr>
<td>New Bedford, MA</td>
<td>Ellsworth-Bar</td>
</tr>
<tr>
<td>Providence, RI</td>
<td>Harbor, ME</td>
</tr>
<tr>
<td>Point Judith, RI</td>
<td>Jonesport, ME</td>
</tr>
<tr>
<td></td>
<td>Searson, ME</td>
</tr>
<tr>
<td></td>
<td>Southwest Harbor, ME</td>
</tr>
<tr>
<td></td>
<td>Stonington, ME</td>
</tr>
<tr>
<td></td>
<td>Ogunquit, ME</td>
</tr>
<tr>
<td></td>
<td>Kennebunkport, ME</td>
</tr>
<tr>
<td></td>
<td>Portsmouth, NH</td>
</tr>
<tr>
<td></td>
<td>Provincetown, MA</td>
</tr>
<tr>
<td></td>
<td>Chatham, MA</td>
</tr>
<tr>
<td></td>
<td>Wellfleet, MA</td>
</tr>
<tr>
<td></td>
<td>Newport, RI</td>
</tr>
<tr>
<td></td>
<td>Montauk, NY</td>
</tr>
</tbody>
</table>
Past, present and potential sites of offshore disposal of domestic (e.g. sewage) and industrial (e.g. wastewater) wastes are potential areas of concern to fish and shellfish habitat. Barr and Wilk (1994) summarized dumpsites in New England waters (Table 13). Two industrial waste dumpsites in the Mid-Atlantic Bight are described which may influence fish and shellfish populations in the New England region. There are no sewage sludge dumpsites in the Gulf of Maine; however, sewage sludge was discharged into Boston Harbor from the Deer Island and Nut Island Waste Water Treatment Plants for decades which ended in December 1991. The discharged material contained toxic heavy metals, oil, and pesticides which has been incorporated in sediments.

Table 13: Past industrial and sewage sludge dumpsites, materials discharged, duration of dumping, and year dumping was ended.

<table>
<thead>
<tr>
<th>SITE</th>
<th>MATERIALS</th>
<th>DURATION</th>
<th>ENDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts Bay Industrial Waste Site</td>
<td>radioactive wastes</td>
<td>100 years</td>
<td>1976</td>
</tr>
<tr>
<td>(42° 27.7'N, 70° 35.0'W)</td>
<td>toxic/hazardous chemicals heavy metals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>located 19 miles off Boston</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acid Waste Site, New York Bight</td>
<td>acid and alkaline wastes</td>
<td>1988</td>
<td></td>
</tr>
<tr>
<td>(40° 16' to 40° 20'N, 73° 36' to 73° 40'W)</td>
<td>located off New York City</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deepwater Dumpsite 106</td>
<td>industrial waste sewage sludge</td>
<td>1991</td>
<td></td>
</tr>
<tr>
<td>(38° 45'N, 72° 20'W)</td>
<td>located 106 miles from New York Harbor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12-Mile Dumpsite</td>
<td>sewage sludge heavy metals</td>
<td>63 years</td>
<td>1987</td>
</tr>
<tr>
<td>(12 miles off Sandy Hook, NJ)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dredging occurs in coastal waters and lands for the maintenance of navigable channels and development. Disposal of dredged material may have serious detrimental impacts to habitat. Historical sites of ocean disposal of dredged material are potential locations of important fish and shellfish habitat (Table 14).

Table 14: Major and minor locations of dredged material disposal, noting several locations off the New York and New Jersey coast that can indirectly impact New England fishery resources (Table partially reproduced from Kurland et al. 1994).
MAJOR SITES | DESCRIPTION
--- | ---
Rockland, ME | 3.3 miles northeast of Rockland Harbor. Has been used since 1973.
Portland, ME | 3.5 miles from Portland Harbor. Has been used since 1973.
Cape Arundal, ME | 2.75 mile southeast of Cape Arundal. Has been used since 1985
Massachusetts Bay, MA | "Foul Area" west of Stellwagen Basin
Buzzards Bay, MA | 1.4 miles from Chappaquoit Point, West Falmouth
New London, CT | 2 miles south of harbor. Has been used since 1972.
Cornfield Shoals, CT | 6.5 miles southwest of the Connecticut River delta.
Central Long Island Sound | 5 miles south of New Haven Harbor. Has been used since 1955.
Western Long Island Sound | 2.7 miles south of Noroton, CT. Has been used since early 1980’s

MINOR SITES

Frenchman’s Bay, ME | Used infrequently.
Saco Bay, ME | Used once in 1989.
Sandy Bay, ME | Used once in 1987.
Cape Cod Bay, MA | Used since 1995
Wellfleet, MA | Adjacent to Wellfleet Harbor entrance. Last used in 1983.

All types of power plants potentially degrade and alter surrounding habitat through water withdrawal and effluent discharges containing contaminants. Several nuclear power plants threaten aquatic and marine environments in New England (Table 15).

Table 15: Nuclear power plants along coastal and riverine habitat in New England.

<table>
<thead>
<tr>
<th>Connecticut</th>
<th>Rhode Island</th>
<th>Massachusetts</th>
<th>New Hampshire</th>
<th>Maine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millstone - Waterford</td>
<td>none</td>
<td>Pilgrim - Plymouth</td>
<td>Seabrook - Seabrook</td>
<td>Maine Yankee¹</td>
</tr>
</tbody>
</table>

¹ no longer operating, ceased in 1997

Navigation of inshore waters requires maintenance that includes channel dredging. Channel dredging potentially adversely effects a suite of biological, chemical, and physical aspects of the environment. Rivers, channels, shoals, ponds, canals, harbors, and bays are potentially dredged to maintain navigable waterways (Table 16).

Table 16: Federal navigation projects in Massachusetts (from north to south).

<table>
<thead>
<tr>
<th>RIVERS</th>
<th>HARBORS / BAYS</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merrimack River</td>
<td>Newburyport Harbor</td>
<td>Provincetown Harbor</td>
</tr>
<tr>
<td>Ipswich River</td>
<td>Sandy Bay</td>
<td>Wellfleet Harbor</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Essex River</td>
<td>Rockport Harbor</td>
<td>Pleasant Bay</td>
</tr>
<tr>
<td>Annisquam River</td>
<td>Pigeon Cove</td>
<td>Stage Harbor</td>
</tr>
<tr>
<td>Island End River</td>
<td>Gloucester Harbor</td>
<td>Buttermilk Bay</td>
</tr>
<tr>
<td>Malden River</td>
<td>Beverly Harbor</td>
<td>Hyannis Harbor</td>
</tr>
<tr>
<td>Mystic River</td>
<td>Salem Harbor</td>
<td>Falmouth Harbor</td>
</tr>
<tr>
<td>Neponset River</td>
<td>Lynn Harbor</td>
<td>Little Harbor</td>
</tr>
<tr>
<td>Weymouth fore</td>
<td>Winthrop Harbor</td>
<td>Woods Hole Harbor</td>
</tr>
<tr>
<td>Town River</td>
<td>Boston Harbor</td>
<td>Wareham Harbor</td>
</tr>
<tr>
<td>Weymouth Back</td>
<td>Dorchester Bay</td>
<td>New Bedford Harbor</td>
</tr>
<tr>
<td>Westport River</td>
<td>Cohasset Harbor</td>
<td>Fairhaven Harbor</td>
</tr>
<tr>
<td>Taunton River</td>
<td>Nantucket Harbor</td>
<td>Fall River Harbor</td>
</tr>
<tr>
<td>Menemsha Creek</td>
<td>Scituate Harbor</td>
<td>Cuttyhunk Harbor</td>
</tr>
<tr>
<td></td>
<td>Green Harbor</td>
<td>Vineyard Haven Harbor</td>
</tr>
<tr>
<td></td>
<td>Duxbury Harbor</td>
<td>Edgartown Harbor</td>
</tr>
<tr>
<td></td>
<td>Kingston Harbor</td>
<td>Nantucket Harbor</td>
</tr>
</tbody>
</table>
Table 17: Non-Fishing Related Threats to EFH and Activities and Sources Contributing the Threats

<table>
<thead>
<tr>
<th>ACTIVITIES &amp; SOURCES</th>
<th>Chemical</th>
<th>Biological</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>erosion control</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>dredge and fill</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>vessel activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>bulkheads</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>jetties</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>groins</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>tidal restriction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>dam construction/operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>water withdrawal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>irrigation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>deforestation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>gravel/mineral mining</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>oil/gas mining</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>seepage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>artificial reefs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>dredged material disposal</td>
</tr>
</tbody>
</table>

"2°" = secondary source

<table>
<thead>
<tr>
<th>non-point sources</th>
<th>Chemical</th>
<th>Biological</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>municipal run-off</td>
<td>X X X X X X</td>
<td>X X</td>
<td>X</td>
</tr>
<tr>
<td>agricultural run-off</td>
<td>X X X X X X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>atmospheric deposition</td>
<td>X X X X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>wildlife feces</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>septic systems</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>industrial shipping</td>
<td>X X X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>recreational boating</td>
<td>X X X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>contaminated groundwater (2°)</td>
<td>X X X X X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>contaminated sediments (2°)</td>
<td>X X X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>nuisance / toxic algae (2°)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>point sources</th>
<th>Chemical</th>
<th>Biological</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>industrial discharge</td>
<td>X X</td>
<td>X X X X X X</td>
<td>X</td>
</tr>
<tr>
<td>power plants</td>
<td>X X</td>
<td>X X</td>
<td>X</td>
</tr>
<tr>
<td>sewage treatment plants</td>
<td>X X X</td>
<td>X X</td>
<td>X</td>
</tr>
<tr>
<td>ocean disposal of dredged material</td>
<td>X X X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>aquariums</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>biotechnology labs</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>silviculture</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>water diversion</td>
<td>X X X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>decaying shoreline structures</td>
<td>X X X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>energy and mineral exploration/transportation</td>
<td>X X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>marine transportation</td>
<td>X X</td>
<td>X</td>
<td>X X</td>
</tr>
<tr>
<td>coastal development</td>
<td>X X X</td>
<td>X X X X X X X X X X X X</td>
<td>X</td>
</tr>
<tr>
<td>port / harbor development</td>
<td>X X X</td>
<td>X X X</td>
<td>X</td>
</tr>
<tr>
<td>erosion control</td>
<td>X</td>
<td>X X X</td>
<td>X</td>
</tr>
</tbody>
</table>

NEFMC EFH Amendment

October 7, 1998
5.7 CUMULATIVE AND SYNERGISTIC IMPACTS

Natural, uncontrolled environments are rarely impacted by isolated threats. A number of threats combine or simultaneously act to change or degrade habitat. Cumulative impacts are the combined outcome of numerous actions and stresses which alone may have relatively minor impacts, yet add up to severe habitat degradation or loss (Vestal et al. 1995). For example, the alteration of habitat through loss of wetlands, degradation of water quality from non-point and point sources of pollution, and changes in water chemistry (e.g. salinity) from water diversion operations can lead to notable losses of habitat both spatially and temporally on a broad scale. Synergistic impacts are a more complex magnification to produce a greater impact than additive effects.

Fishing and non-fishing activities influence habitat function. Depending on the characteristics of habitat, including spatial and temporal variations, physical, biological, and chemical properties, a suite of potential deleterious actions and threats, both human and natural threats, can impact habitat differently. Current programs to assess and mitigate cumulative impacts in coastal regions are reviewed in Vestal et al. (1995) and include:

- The U.S. Fish and Wildlife Service Cause / Effect Process
- EPA’s Synoptic Approach
- Alaska’s Assessment of Cumulative Impacts on Fish Habitat in the Kenai River
- Regional Ecological Risk Assessment
- A Landscape Conservation Approach
6.0 CONSERVATION AND ENHANCEMENT MEASURES

6.1 INTRODUCTION

The Magnuson-Stevens Fishery Conservation and Management Act requires all fishery management plans (FMPs) to identify actions to promote the conservation and management of fishery resources. Prior to the concept of essential fish habitat (EFH), conservation primarily involved management measures to reduce overfishing and rebuild overfished stocks. Such measures embraced the need to minimize and avoid the mortality of bycatch. While these issues remain very important in fishery management, the EFH amendment will strengthen the role of the New England Fishery Management Council to further conserve and enhance EFH and related fishery resources.

The regulatory text of the Interim Final Rule directs the Council to describe options to avoid, minimize, or compensate for the adverse effects of activities identified in the non-fishing threats section of this amendment. The Interim Final Rule also directs the Council to promote the conservation and enhancement of EFH, especially in habitat areas of particular concern. The Council has the discretion to provide comments on non-fishing activities authorized by federal and state agencies which impact the EFH of non-anadromous fish species. The conservation and enhancement options promoted by the Council include, as directed in the Interim Final Rule: the enhancement of rivers, streams, and coastal areas; improving water quality and quantity; watershed analysis and planning; and habitat creation. The enhancement of rivers, streams, and coastal areas may include reestablishing endemic trees or other appropriate native vegetation on riparian areas adjacent to EFH, restoring natural bottom characteristics, removing unsuitable materials from areas affected by human activities, or adding gravel or substrate to stream areas to promote spawning. Improving water quality and quantity may include the use of best land management practices, improved treatment of sewage, proper disposal of waste materials, and providing appropriate in-stream flows. Watershed analysis and planning may include encouraging local and state efforts to minimize destruction/ degradation of wetlands, restore and maintain the ecological health of watersheds, and encourage the restoration of native species. Habitat creation may be considered as a means of replacing lost or degraded EFH.

This section of the amendment primarily addresses recommendations from the Council to other organizations and agencies. The fishing impacts section of the amendment addresses those activities and measures that the Council is currently taking, or is considering, to mitigate the adverse impacts to EFH associated with fishing activity under the Council's jurisdiction. By developing and articulating the options suggested to avert or minimize non-fishing threats to EFH, the Council defines its position relative to these types of activities. In developing mitigation recommendations, the Council applied the definition of mitigation used by the President’s Council for Environmental Quality. This definition focuses on mitigation as a means of sequentially avoiding impacts, minimizing impacts, and compensating for remaining unavoidable impacts, and provides five types or categories of mitigation:

1. *Avoiding* the impact by not taking a certain action or parts of an action.
2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
3. Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
4. Reducing or eliminating the impact over time by preservation and maintenance during the life of the action.
5. Compensating for the impact by replacing or providing substitute resources or environments.

The first step in the process for developing conservation and enhancement recommendations was to develop working definitions of the terms conservation, enhancement, and restoration. A working definition of restoration is worth noting because of the interrelation of this issue with the conservation and enhancement of habitat and fishery resources. The following definitions serve as terms of reference for the Council’s EFH process:

- **Conservation** ≡ The rules, regulations, conditions, methods, and other measures which are useful in rebuilding, restoring, or maintaining, any fishery resource and the marine, aquatic, estuarine, or riparian environment (adapted Magnuson-Stevens Fishery Conservation and Management Act).
- **Enhancement** ≡ Activities conducted in existing marine, aquatic, estuarine, or riparian areas, which improve one or more of the ecological functions and/or the biodiversity of existing, but degraded or impoverished, habitats (NOAA. 1995 and Pywell, R. and P. Putwain. 1996).
- **Restoration** ≡ Re-establishment of marine, aquatic, estuarine, or riparian resource characteristics and function(s) at a site where they have ceased to exist, or exist in a substantially degraded state (adapted from NOAA. 1995).

Details on how the Council will distribute this information to the federal and state agencies targeted are provided in the EFH Strategic Plan (Section 8.3). The Strategic Plan also describes the Council’s role in the federal EFH consultation process, how the Council will interact with the federal or state agencies targeted with conservation and enhancement recommendations, and the process the Council will use to determine and prioritize activities warranting Council attention.

### 6.1.1 New England Fishery Management Council’s Authority

The Magnuson–Stevens Act empowers the federal government to manage fishing from three miles offshore to 200 miles [Exclusive Economic Zone (EEZ)] and established the Regional Fishery Management Councils that are managed by the Secretary of Commerce. The Council’s existing FMPs are amended with the development of this EFH amendment, and all future FMPs and other Council actions and recommendations will include EFH considerations. The EFH amendment will strengthen the New England Fishery Management Council’s involvement in habitat consultation processes. The Sustainable Fisheries Act (SFA) gives direct authority to the Council to comment and make recommendations on all...
environmental issues that occur within or indirectly impact habitat designated as EFH. The Council has the authority to comment on habitat issues in federal, state, and international waters. Federal waters include marine waters from the three mile state jurisdiction line offshore to the 200 mile Hague Line and EEZ boundary. State waters are not limited to coastal waters, but also estuarine, riverine, and terrestrial habitats that directly influence aquatic and marine environments. Activities in Canadian waters may also directly influence the fishery resources of New England.

The Council will assist the agencies discussed below to incorporate EFH considerations into existing projects and future programs. The Council will require assistance and support from federal and state agencies and non-governmental organizations to promote an awareness of EFH and develop and implement conservation and enhancement measures to protect EFH from fishing and non-fishing impacts (Sections 4.0 and 5.0). The Council is required to establish procedures for reviewing federal and state actions that may adversely affect the EFH of any species managed under its authority, and to cooperate with the National Marine Fisheries Service (NMFS) as closely as possible to identify actions that may adversely affect EFH, to develop comments and EFH conservation recommendations to federal and state agencies, and to provide EFH information to federal and state agencies.

The Council’s partnership with NMFS derives from the NMFS Habitat Conservation Policy (FR 53142-53147), specifically Implementation Strategy 3, which provides a process to assess, comment, and make recommendations on habitat issues. Prior to the EFH provisions of the Sustainable Fisheries Act, there was no mandate for the Council to review state activities and the consultation primarily was limited to commenting on activities in federal waters. EFH broadens the scope of consultation to any activity that potentially impacts habitat necessary for the development of any life history stage of federally managed species. The Council will fulfill its obligation under the Magnuson-Stevens Act regarding the EFH by working closely with NMFS in the consultation process. Details of the process to be used by the Council to coordinate with NMFS in the consultation process are provided in the EFH Strategic Plan (Section 8.2).

The Magnuson-Stevens Act requires that the Council review and comment on any activity which is likely to substantially affect the habitat of any anadromous fishery resource under its authority. In addition to Atlantic salmon, this includes species such as river herring, striped bass, and American shad. The Council plans to work closely with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, the states, and the Atlantic States Marine Fisheries Commission to meet this obligation.

The Council has developed a process to review and comment on activities that may influence EFH of any managed species. The following groups were formed with specific tasks in the development of the EFH Amendment and will assist with future decisions related to EFH (see Sections 2.5, 8.1, and 8.4):

- **Habitat Oversight Committee**: the Committee consists of Council members that are responsible for bringing habitat issues to the attention of the entire Council for
review and consideration. Other tasks may include developing position statements on particular issues that may impact EFH and developing recommendations for the protection of EFH.

- **Habitat Advisory Panel**: advisors are responsible for reviewing EFH-related issues and information and providing assistance to the Committee as needed.

- **EFH Technical Team**: members are responsible for technical oversight of all EFH documents drafted for Committee review and provide technical information to the Committee as needed.

The following sections provide recommendations to address fishing (section 4.0) and non-fishing threats (section 5.0) previously discussed. The recommendations primarily are targeted to federal and state authorities that are responsible for developing and enforcing conservation and enhancement measures for particular natural resources that may influence EFH. Certain recommendations also apply to non-government organizations and the general public.

### 6.2 RECOMMENDATIONS TO ADDRESS FISHING THREATS

Conservation and enhancement measures to protect fishery resources from fishing activities will include current fishery tactics and emerging fisheries that are not regulated and may present environmental considerations in the future. Where gear types regulated by the Council are used in similar habitats in state waters or federal waters outside the jurisdiction of the NEFMC, Council recommendations may take the form of suggestions that the states or other entities (such as the Atlantic States Marine Fisheries Commission, the Mid-Atlantic Fishery Management Council, or NMFS) adopt similar habitat protection measures as implemented by the NEFMC. When different gear types are used in these waters, the Council may recommend identifying and, if necessary, developing the means to reduce the impacts of those gears on essential fish habitat. Fishing threats under the authority of the Council are addressed in Section 4.0. The Council is not prepared to make specific recommendations at this time.

Other fishing related activities, such as aquaculture and fish processing plants operating at-sea (e.g. within the water), may present substantial impacts to Council-managed resources (see Sections 4.7 and 4.8). The Council may find certain operations are having substantial impact on EFH and determine mitigation is necessary. The following recommendations address the Council's concerns with these activities:

- To reduce the risk associated with at-sea aquaculture and fish processing, the Council recommends facilities be sited in the least environmentally harmful locations. The siting should include a thorough investigation of the natural resources and environmental conditions at the proposed development sites and surrounding habitats.

- The Council recommends that EFH designations be considered in the development and construction of any aquaculture and processing operation, and
these activities be discouraged in HAPC.

- The Council recommends that aquaculture and processing operation discharge be closely monitored and discharge levels be strictly enforced to ensure safe levels of potential chemical and biological threats.

6.3 RECOMMENDATIONS TO ADDRESS ANTHROPOGENIC NON-FISHING THREATS TO EFH

The non-fishing threats assessment serves to identify the variety of threats of primary concern, including the threats for which the Council may consider recommending action to lessen potential impacts (see section 5.0). The Council has developed a list of recommendations to federal, state, and local agencies and non-governmental organizations to consider implementing into existing or developing conservation and enhancement programs. The Council will provide recommendations to address non-fishing threats to the appropriate action agencies and recommend the agencies incorporate EFH into all existing habitat-related programs when the EFH designations occur within their jurisdiction. If particular organizations do not have programs to address non-fishing related issues, the recommendation will be that the particular organization should develop a program to mitigate a specific concern or a suite of environmental issues that potentially impact EFH occurring within their jurisdiction. In general federal and state agencies should, to the extent of their authority, take proactive approaches to reduce non-fishing threats to EFH in riverine, inshore, and offshore waters. The following recommendations address mitigation options for chemical, biological, and physical threats to essential fish habitat in the New England region.

6.3.1 Chemical Threats

Oil Spills

- The U.S. Coast Guard (USCG), in collaboration with other federal, state, and local agencies should continue to update and implement coastwide area contingency plans and incorporate EFH mapping to ensure the rapid and effective response to discharges of oil and hazardous substances in the marine environment. Plans should include a prioritization of clean-up plans to protect known areas of high productivity (e.g. HAPC).
- State environmental agencies should develop contingency plans for addressing oil spills in rivers (particularly rivers designated as HAPC for Atlantic salmon), estuaries, and other inshore habitats, if this task is not yet completed.
- The USCG should integrate EFH maps into the coastwide area contingency plans.
- State and federal resource agencies should develop and implement a policy on the use of oil spill chemical counter measures (e.g. dispersants) to protect EFH from the adverse effects of oil spills.
- Municipalities should establish and promote the use of used motor oil collection facilities to ensure proper collection and disposal of used motor oil from the general public to mitigate the threat of oil entering the environment and potentially impacting...
EFH.

- Federal, state, and local agencies and nonprofit organizations should work together to educate the public, particularly car and boat owners, about the potential hazards of petroleum products discharged to marine, estuarine, and riverine habitats.

Heavy Metals and Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), Pesticides and other Toxic Organic Compounds

- State agencies and business communities should form partnerships to facilitate safe management of hazardous products, emphasizing recycling and reduced use of hazardous products wherever possible, to reduce the potential threat of toxicants entering the environment and impacting EFH.
- EPA and state regulators should carefully monitor discharge monitoring reports of NPDES permit holders and work with them to ensure that they are in compliance with their heavy metals, PAHs, PCBs, pesticide, and other toxic organic compound limits to mitigate impacts on EFH.
- Municipalities should establish household hazardous waste collection programs to ensure the proper disposal of hazardous products to reduce the potential threat of toxicants entering the environment and impacting EFH.
- Municipalities should adopt and implement the following types of regulations to ensure the safe use, storage, and disposal of hazardous materials for the conservation of EFH: 1) hazardous materials regulations, 2) underground storage tank regulations, and 3) commercial and industrial floor drain regulations.
- Federal and state agencies should identify and form a database of contaminated sediments that may pose substantial threats to fishery resources and EFH for New England coastal, estuarine, and riverine benthos.
- Federal, state, and local agencies and nonprofit organizations should work together to educate the public about the potential problems of hazardous wastes discharged to marine, estuarine, and riverine environments that may potentially impact EFH.
- Wastewater treatment facilities need to continue their efforts to require pretreatment and recycling from industries that produce hazardous wastes so that these wastes do not reach the marine environment and impact EFH.

Chlorine

- EPA and state regulators should carefully monitor discharge monitoring reports of NPDES permit holders and work with them to ensure that they are in compliance with their chlorine limits to mitigate impacts on EFH.
- Where feasible, other methods of disinfecting wastewater, such as UV irradiation, should be used instead of chlorine to minimize or remove any level of chlorine discharge.
- In cases where human health concerns from the consumption of contaminated shellfish or from contact with contaminated water are not issues, EPA, state regulators, and wastewater treatment facilities operators should consider eliminating the use of chlorine, at least seasonally, to reduce the amount of chlorine entering the environment that can potentially impact EFH.
In general, all agencies and industries should consider developing innovative and cost-effective methods to minimize and reduce levels of chlorine discharged into EFH, while enhancing or maintaining water quality.

**Nutrients**

- States should identify nitrogen sensitive embayments containing EFH, building on work that has been carried out in New England coastal states through the National Estuaries Program. Planning agencies, in collaboration with state environmental agencies and local officials, should determine critical loading rates and recommend actions to prevent or reduce excessive nitrogen and phosphorous loading to EFH, including freshwater spawning sites of anadromous fish, estuaries, and coastal water, all of which may be EFH.
- Actions to prevent or reduce nitrogen loading to protect EFH could include discouraging or banning the use of lawn fertilizers, requiring denitrifying systems on septic systems and nitrogen removal by wastewater treatment facilities, the protection of vegetated buffer zones and wetlands surrounding rivers and estuaries, the protection of open space, the use of catch crops by agriculture industries to reduce the amount of nutrient rich run-off between growing seasons, and development limits.
- The Natural Resource Conservation Service and state agricultural agencies should work with farmers to implement best management practices (BMPs) to reduce nutrient runoff entering EFH from the agriculture industry.
- The EPA, working with state environmental agencies, should require water quality standards that enhance and protect nitrogen-sensitive coastal embayments containing EFH. Specifically, the EPA and state agencies should strengthen enforcement of sewage discharge permits (e.g. NPDES) and ensure proper maintenance and operation of septic systems.
- Federal, state, and local agencies and nonprofit organizations should work together to educate the public, particularly agriculture industries, about the potential hazards of excess nutrients discharged into marine, estuarine, and riverine habitats that may contribute to the degradation of EFH.

**Thermal Discharges**

- Thermal pollution should be minimized in EFH, especially in areas known to have high productivity and important habitat parameters.
- Permitting agencies should insist that all life history stages of organisms, especially eggs and larvae, be assessed relative to thermal impacts on local spawning populations as well regional stocks when issuing discharge permits to power plants.

**Suspended Solids**

- For the protection of EFH in rivers with particular reference to anadromous fish and estuaries, municipalities should adopt subdivision regulations that require the incorporation of stormwater runoff BMPs and EFH mapping into all new development plans that specifically prevent sedimentation.
• The Natural Resource Conservation Service and state environmental agencies should disseminate information on EFH, BMPs, and financing options for controlling stormwater runoff and mitigating existing problems. This information should be targeted particularly toward state and local public works and highway departments.

• State highway departments should prepare design manuals (e.g. stormwater management guides) that integrate environmental considerations and EFH mapping into all phases of highway project planning, design, construction, and maintenance. The highway departments should schedule annual workshops for local departments on the importance of reducing suspended solids entering aquatic and marine environments.

• Highway Departments should require the consideration of EFH designations and the use of on-site stormwater BMPs as a precondition to the permitting of private property tie-ins to state drainage facilities.

6.3.2 Biological Threats

Nonindigenous Species / Reared Organisms

• State environmental agencies need to strictly regulate research projects, biotechnology laboratories, and aquariums (and aquaculture – see Section 6.2) to ensure that reared organisms do not escape or are not intentionally released without strict guidelines. Strict measures and enforcement guidelines should be developed and required to reduce the threat of nonindigenous or reared organisms that may change the natural functions of habitats and populations dynamics within New England waters, particularly within EFH. The scientific community and general public needs to be alerted to the seriousness of the potential environmental problems related to the release or escapement of nonindigenous and reared organisms.

• Public awareness of this issue needs to be raised so that people understand the threat that nonindigenous and reared organisms pose to our marine and aquatic ecosystems, specifically within EFH. This enhanced awareness would help reduce the inadvertent introduction of organisms attached to boat hulls, released in ballast water, escaped from aquaculture facilities, released from domestic aquariums, etc.

• Specifically, a comprehensive effort needs to be undertaken by state wetlands agencies to reduce the spread of *Phragmites* in coastal marshes, primarily by mitigating the effects of tidal restrictions. State regulatory frameworks need to be adjusted, if necessary, to allow reasonable restoration projects that promote the rehabilitation of natural processes and communities that protect and enhance EFH and other environmental interests.

Nuisance / Toxic Algae (Harmful Algal Blooms)

• See “Nutrients” section

• A comprehensive federal, state, and local effort should be initiated to reduce the threat of nuisance / toxic algae from spreading spatially and temporally that may impact fishery resources and EFH.
Pathogens

- A comprehensive effort should be initiated by federal, state, and local agencies to reduce the threat of pathogens, either occurring naturally or released accidentally, from spreading spatially and temporally and thereby impacting fishery resources and EFH.

6.3.3 Physical Threats

Channel Dredging and Disposal of Dredged Material

- State programs should incorporate EFH mapping to determine proposed dredging locations and disposal sites to minimize impacts on EFH.
- State environmental agencies should coordinate the development of a comprehensive dredging and dredged material disposal plan to improve and maintain access to ports, harbors, and channels, and to minimize adverse impacts to EFH.
- Any dredging of channels or dredged material disposal should be timed to avoid impacting EFH of migratory fish (e.g. Atlantic salmon), spawning fish (e.g. winter flounder), or critical life stages (e.g. larval and juvenile fishes).
- Any new dredging or disposal sites should avoid impacting areas designated as EFH and attempt to minimize environmental impacts in surrounding areas. For channels subjected to maintenance dredging, an alternative analysis should be carried out if these channels have become HAPC since the last time it was dredged to consider mitigating impacts to EFH.
- The performance standard for dredging and disposal should incorporate that any dredging or disposal shall not degrade EFH.

Protecting Coastal and Inland Wetlands from Dredge and Fill Operations

- All New England states should adopt and implement a policy to not allow any net loss of wetlands to ensure the protection of coastal and riverine EFH.
- In order to replace the large acreage of wetlands lost and degraded from past dredge and fill operations, all coastal states should work with the NMFS Habitat Division, NMFS Restoration Center, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers, to facilitate the restoration of salt marshes and other estuarine habitats to promote the recovery of fishery resources and enhance EFH. States should have programs such as the Massachusetts Wetlands Restoration and Banking Program that provide technical and financial assistance and work with communities and non profit organizations to identify potential sites and implement projects.
- State and federal regulations governing wetlands need to be adapted to allow the streamlining of legitimate restoration projects for quick and thorough protection and enhancement of EFH.
- State and local land protection agencies should work together to identify and then acquire critical parcels of land whose acquisition would protect coastal and riverine EFH by preventing any dredging and filling operations. These might include areas surrounding anadromous fish spawning habitats, buffer zones around coastal...
wetlands, the coastal wetlands themselves, and natural corridors adjacent to rivers where anadromous fish run.

Marina and Dock Construction

- Marina and dock facilities should be constructed and maintained in a manner that EFH is not degraded either by the structures themselves or by the vessel activity they engender. This includes constructing docks and piers such that submerged vegetation is not degraded, sedimentation patterns are not altered, and water quality is maintained.
- New technology in mooring chains (e.g. Helix and Manta Systems) should be encouraged to minimize environmental impacts associated with mooring use and minimize the chain dragging on the bottom which damages submerged vegetation and other EFH benthic features.
- Coastal communities should be encouraged to adopt harbor management plans to protect EFH. These would indicate where the most appropriate, least environmentally damaging locations are for any new or expanding marinas and docks. To reduce the overall footprint of marinas and docks and EFH environmental impacts, emphasis should be placed on community piers accessible to all residents and maritime businesses that will centralize vessel activity.

Vessel Activity

- Boat channels should avoid passing over shallow EFH (e.g. submerged vegetation habitats) that might be subject to erosion or siltation from prop wash.
- Vessel owners need to be educated by Coastal Zone Management offices, the Coast Guard, and local harbormasters about the need to adhere to no wake zones in order to prevent or minimize damage to EFH. State and local agencies should integrate EFH mapping and develop methods of reducing the degradation of coastal marshes, erosion of submerged aquatic vegetation beds, and siltation of shellfish flats to minimize vessel-induced impacts to EFH.
- No vessel discharge zones and pump out facilities that are approved by the states and/or EPA should be encouraged to reduce the potential threats.
- State and federal agencies and non-profit groups should promote education programs on environmentally safe boating to recreational boaters to reduce impacts on EFH.

Erosion Control

- Bulkheads, seawalls, jetties, groins, and other erosion control structures should be designed and located to avoid creating any impacts on EFH, such as interrupting the natural flow of sand to EFH.
- Municipalities should incorporate EFH mapping into existing erosion control programs and adopt and implement strict development/redevelopment standards within the Federal Emergency Management Act A and V flood hazard zones and other areas subject to coastal flooding, erosion, and sea level rise. Communities should also develop effective floodplain management regulations that consider EFH.
Tidal Restrictions

- All coastal states should integrate EFH mapping into existing programs and work with the NMFS Habitat Division, NMFS Restoration Center, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers, to restore habitat conditions degraded from altered hydrology. States should have programs, such as the Massachusetts Wetlands Restoration and Banking Program, that provide technical and financial assistance and work with communities and non profit organizations to identify potential sites and implement projects.
- All coastal states should adopt a policy that any construction project, including public works projects, within or adjacent to EFH will not restrict the tidal flow or alter freshwater inflows in any way.
- State highway departments and local departments of public works should be educated about the need to maintain or increase tidal flow through culverts such as those underneath roads and railroad corridors. These flows protect and restore ecological functions potentially important to EFH and fishery resources.
- Wildlife agencies should be discouraged from creating impoundments in tidal areas. Generally, these areas eventually degrade into brackish marshes dominated by invasive vegetation that potentially disrupt and degrade the natural functions of EFH or hinder the accessibility of organisms to important habitats.

Dam Construction/Operation

- Fisheries agencies should prepare an up to date inventory of anadromous fish runs incorporating EFH mapping and designations and develop a strategy to prioritize, restore, and maintain these runs.
- State fisheries agencies should implement a citizen-based fishway stewardship program to restore and maintain EFH in New England rivers and estuaries.
- Fish and wildlife agencies should put funding in place to ensure the proper maintenance of fishways for the protection and restoration of riverine dependent fishery resources and EFH.
- Natural resource agencies, working with local officials and organizations, should identify dams that are no longer functional and are therefore candidates for removal. State agencies should modify regulations that hinder the removal of such dams when removal is in the best interest of enhancing EFH for anadromous species and protects other environmental interests.

Water Diversion/Withdrawal

- The state agency responsible for water management should integrate EFH mapping into existing or developing programs and develop and promote the use of river basin plans to facilitate responsible water resource planning and management at local and regional levels.
- Standards for water withdrawals should include that EFH not be degraded.
- Municipal water resource agencies should be required to make water conservation
devices available to the public and to educate the public about the need to conserve water for the protection of fishery resources and EFH. State agencies should set conservation goals that include protecting EFH to enhance fishery resources.

- Yearly assessments should be carried out by the state agency responsible for water management to determine if municipalities are complying with their water use permits. Those that exceed their allocated withdrawals should be fined and the money used for restoring riverine anadromous fish EFH.
- Existing power plants should be retrofitted with the best technology available to minimize plant-induced entrainment and impingement mortalities.
- Thorough fisheries assessment, including ichthyoplankton surveys, should be incorporated into all entrainment studies by power plants that withdraw water from inshore regions.

**Deforestation**

- Municipalities should prepare and implement a state-approved open space plan to preserve and protect key wetlands and migration corridors that contribute to environmental conditions of EFH.
- Municipalities should adopt and implement river protection districts to protect riverine EFH. States should develop and promote the use of river basin plans that protect EFH and other environmental values.
- State and local land protection agencies should work together to identify and then acquire critical parcels of land whose acquisition would protect coastal EFH through the prevention of deforestation. These areas might include land surrounding anadromous fish spawning habitats, buffer zones around coastal wetlands, the coastal wetlands themselves, and natural corridors adjacent to rivers where anadromous fish run.
- Local conservation commissions and planning agencies should require the maintenance of the most appropriate naturally vegetated buffer strips around coastal wetlands, rivers, and anadromous fish spawning sites that have been designated as EFH.

**Mining**

- Mining that alters the sedimentary composition (e.g. sand and gravel) or other important environmental features (e.g. depth) should be banned from any area designated as EFH for demersal species or organisms with demersal life stages.
- Performance standards of any other mining operations (e.g. oil and gas, peat) should include a provision not to alter EFH.
- All mining should be prohibited from HAPC.

**Debris**

- Coastal municipalities should work cooperatively with Coastal Zone Management offices, neighboring communities, and waterfront users to design and implement
beach and marine debris reduction programs to reduce the threat of debris impacting EFH.

- CZM offices, municipalities, and NGOs should continue their efforts to educate the public on the hazards of marine debris to certain marine life and EFH.

Artificial Reefs

- EFH should be considered and incorporated in any Army Corp of Engineer or state fishery agency plans to develop artificial reefs to enhance fishery resources.
- Artificial reefs should only be constructed with materials and methods that do not adversely impact EFH.

6.4 PROACTIVE MEASURES TO IMPROVE HABITAT CONSERVATION AND ENHANCEMENT

Management approaches to mitigate adverse impacts from fishing and non-fishing activities that address the previous recommendations from the Council to other regulatory, collaborative, and non-governmental agencies may include proactive conservation and enhancement measures to protect EFH. Research, models, and theories present several alternative conservation and enhancement approaches to protect marine resources. Methods to complement the traditional management strategies based on stock assessments to protect and maintain sustainable levels of fisheries have been discussed, and scientific information is beginning to support other techniques to conserve and enhance fishery resources.

There are a variety of designations and techniques that are used to classify approaches to protect and enhance fishery resources, other than single stocks or stock complexes, with a wide range of objectives. Objectives of the approaches include conserving biodiversity, promoting tourism, protecting sensitive habitats, providing refuge for overexploited organisms, enhancing production of selected species, providing management guidelines for multiple use resources, serving as demonstration projects, or a combination of these goals (reviewed by Allison et al. 1998). The following potential management measures may be considered by the Council for the conservation and enhancement of essential fish habitat.

6.4.1 Marine Protected Areas

Conservation and enhancement measures based on closing a marine area to a particular or all activities has potential benefits to EFH and fishery resources of the New England region. Marine protected areas (MPA) potentially reduce or stop actions that adversely impact EFH important to the sustainability of fisheries. MPA is a generic term defined as any area of intertidal or subtidal terrain, together with its overlying waters and associated flora, fauna, and historical and cultural features, which has been reserved by legislation to manage and protect part or all of the enclosed environment (the 4th World Wilderness Conference).
MPAs exist in an array of sizes, configurations, and denominations, but they all afford some level of habitat protection. MPAs include marine or harvest refugia, fishery reserves, non-extractive parks or reserves, marine reserves, marine sanctuaries, marine or national parks, cross shelf reserves, ‘no-take’ marine reserves, biosphere reserves, conservation zones, marine zoning, and closed areas. Each concept presents similar habitat protection hypotheses and goals that the Council may want to investigate to protect EFH and its fishery resources. Regulatory agencies with direct authority to protect other natural resources, apart from fishery stocks, could be involved with managing MPAs to further protect habitat conditions from activities not related to fishing (e.g. ‘no discharge zone’ administered by the EPA or ‘critical habitat areas’ administered by NMFS and USFWS under the Endangered Species Act). Collaborative efforts between the Council and other agencies to develop and manage MPAs may be initiated to protect, conserve, and enhance EFH in the New England region.

Research has demonstrated that fish distributions can be closely associated with specific small-scale habitat conditions (Langton et al. 1995). Specific associations between fish and habitat conditions have also been documented through ontogenetic development studies (Auster et al. 1997). Refugia designations based solely on fishery independent data demonstrating stock abundance and distribution are not intended to correctly capture important habitat functions. Refugia based on other physical, chemical, and biological features that serve a variety of ecological functions may illustrate more easily defined and static habitat conditions that are important to fishery resources. Management methods to protect critical ontogenetic stages of organisms that react to the dynamic relationships between the environment and fish stocks potentially represent appropriate conservation and enhancement measures for the Council to consider. MPAs developed to protect EFH may support sustainable levels of finfish, shellfish, and mollusk stocks.

Marine refugia have been discussed as a method to protect fishery stocks in the management of commercial fisheries, but few studies have focused on the use of refugia to conserve seafloor habitats that serve important ecological functions for targeted fishes and invertebrates (Lindholm et al. In Press). Specifically, postlarval settlement reserves may present a management technique to protect habitat for early life history fishes to obtain refuge and suitable nutrition conditions before emigrating out of the reserve at a larger size (Auster and Malatesta 1995). Refugia designed specifically to protect juvenile fishes may include habitat with great complexity and consider juvenile migration patterns and size of populations, since juvenile fishes are often migratory (Lindholm et al. In Press). In general, increases in habitat complexity refer to greater vertical relief and increased variability in the size of interstices between structures and may result in higher survivability of demersal juvenile fishes (Auster and Malatesta 1995; Lindholm et al. In Press). The application of refugia designed to protect seafloor habitat with the highest complexity may increase recruitment to exploited fish populations in the New England region (Lindholm et al. In Press).

Research documents the importance of specific bottom topography to the survivorship of newly settled juvenile fishes (e.g. Lough et al. 1989; Valentine and Lough 1991; Gotceitas and Brown 1993; Tupper and Boutilier 1995; Tupper and Boutilier 1995;
Specific examples illustrate the close relationships between surficial sediments and emergent epifauna with juvenile haddock (Melanogrammus aeglefinus), Atlantic cod (Gadus morhua) (e.g. Lough et al. 1989), and whiting (Merluccius bilinearis) (Auster et al. 1997). In support of these observations, research on the settlement of these juvenile fishes on preferential surficial sediments and biogenic structures have demonstrated increased survivorship, growth rate, and predation refuge of fishes associated with highly complex habitats (e.g. Tupper and Boutilier 1995; Tupper and Boutilier 1995; Auster et al. 1997). These particular examples are only a few of the available research projects demonstrating the importance of habitat conditions to the survivorship of early life history fishes, supporting management measures to protect seafloor habitat critical for post settlement fishes.

Marine reserves, in general, potentially serve as a conservation buffer from the lack of scientific information that limits management measures to directly conserve EFH, and potentially improve the long-term sustainability of fishery resources (Lauck et al. 1998). Reserves may be important for conservation efforts because they provide direct protection for habitat, they can provide refuge for commercial organisms, and act as a potential buffer for unforeseen population fluctuations (Allison et al. 1998). Designating a reserve or any closed area alone is insufficient for the protection of EFH and related fishery resources because they are not isolated from surrounding impacts. Efforts to complement reserve dynamics must be made outside the reserve designation to control potential in-coming threats (Allison et al. 1998).

Marine sanctuaries (Dixon 1993; Sobel 1993) have been nationally designated to protect known inhabitants (e.g. corals, seagrasses, marine mammals, and fishery resources). The National Marine Sanctuary Program is a federal program specifically designed to provide comprehensive protection of marine environments in U.S. waters (Sobel 1993). Marine sanctuaries have been recognized for the potential to preserve species and genetic diversity (Policansky and Magnuson 1998) and habitat heterogeneity (Sobel 1993), along with containing valuable economic resources important to local and national economies (Dixon 1993). The Stellwagen Bank National Marine Sanctuary is the only nationally designated region in New England federal waters. It was recognized for its abundance of marine mammals and fishery resources and was designated in 1993 (Auster et al. In Press). National Marine Sanctuaries have their own management plans that may include conservation and enhancement measures to protect fishery resources. Marine protected areas designated as marine sanctuaries may also contribute to increasing public awareness and support for marine conservation and provide research and monitoring areas to advance the available scientific information on the importance of protecting EFH.

Marine or national parks have been identified by the International Union for the Conservation of Nature (IUCN) to protect natural and scenic areas of national or international significance for scientific, educational, and recreational use and to provide ecosystem stability and diversity. Marine parks have been generally limited to tropical coral reef environments that support local economies with tourism. Measures to form
parks may contribute to the conservation, protection, and enhancement of EFH and the sustainability of fishery resources.

Cross shelf reserves is a concept being investigated in the southeast U. S. Cross shelf reserves are proposed to preserve the genetic integrity of tropical reef fishes (Auster et al. In Press). This type of MPA would protect areas across the continental shelf that run perpendicular to the coast. This concept may warrant further research to prove its effectiveness as management measure in New England waters.

‘No-take’ marine reserves as described by Ballantine (1995; 1996) are a network of closed areas based on general principles to assist in fishery management. This approach is underway in other parts of the world (e.g. New Zealand). There may not be data to support decisions on the spatial and temporal boundaries of the ‘no-take’ reserves, but the network of closed areas may promote the conservation and enhancement of EFH conditions and associated organisms. Further research is needed to investigate the assumption that ‘no-take’ reserves enhance fish populations by a ‘spillover’ effect (e.g. fish emigrate from protected areas to fishable areas).

The biosphere reserve concept originated from the need to more systematically preserve genetic resources within a representative terrestrial ecosystem through rational use of natural resources. Its applicability to coastal marine resources has recently been discussed. The IUCN states the objectives of a biosphere reserve program are to provide a network of protected areas representative of the world’s ecosystems and to develop effective models for conservation, research and monitoring, training and education, and sustainable development. The biosphere reserve concept is based on a hierarchical method to protect natural resources. The center of the reserve would be completely protected against any activity, the surrounding habitat protected against a few major threats, and the further outward adjacent habitat only protected against the major recognized threat to any given habitat property. The ‘bull’s eye’ approach can present as many levels as appropriate to conserve a given environmental condition. Biosphere Reserve programs in European nations attempt to protect terrestrial and aquatic habitats along a coastal region for the conservation of marine resources (reviewed by Batisse 1990).

Marine zoning has been discussed and used in fishery management as a regulatory tool to protect fishery resources (Bohnsack 1996). Zoning is a common approach to terrestrial land management, but is controversial in marine or aquatic environments (Bohnsack 1996). Marine zones may be used to designate and separate fishing areas for particular fisheries that are in conflict. Zoning can potentially present a range of protective measures for a large geographic region. Similar to the biosphere reserve concept, zoning can prohibit certain activities in some regions and allow the same actions in adjacent habitats depending on environmental conditions and the type of activity. This may be particularly useful for many species and life stages vulnerable to gear selectivity and release mortality (Bohnsack 1996).

Closed areas represent a level of MPA that the Council may continue to use to protect
EFH for the sustainability of fishery resources. Areas closed to some level of fishing and non-fishing activities are a potential tool to protect EFH. The designation of long-term closures has resulted in the removal or reduction of fishing effort from important fishing grounds (Fogarty and Murawski 1998). This approach to protect fishery resources primarily for the purpose of reducing fishing effort has been implemented in the New England region with the designation of closed areas such as Closed Area I and II and Nantucket Lightship Closed Area. Closed area may be indirectly serving as conservation and enhancement measures for the protection of EFH.

6.4.2 Management Approaches

The Council may want to consider several other management approaches and measures to conserve and enhance EFH. Research documents the effectiveness of proactive measures to protect habitat such as restoration, enhancement, and rotational management. The variety of methods to manage EFH and fishery stocks may most effectively occur under an integrated process. The integrated management technique may be analogous to the Council’s mission of allowing unconditional access to the fishery management process, but the Council may want to take a more active role orchestrating the time and effort of all natural resource users and competitors.

Restoration efforts have been documented to promote the conservation and enhancement of fishery resources. The Council has adopted a definition of restoration, and may consider similar concepts to protect or re-establish degraded habitats. Other related terms include rehabilitation, reclamation, re-creation, and ecological recovery (Meffe and Carrol 1994). The majority of restoration has been limited to coastal environments, but has had notable impacts on improving ecological functions of particular habitats. For example, efforts have been focused on re-establishing tidal flow to salt marshes to mitigate the impacts resulting from tidal restriction (Burdick et al. 1997). The tidal restorations at Mill Brook Marsh, NH and Drakes Island, ME have had a positive influence on local resources (Burdick et al. 1997), and may serve as examples to other areas to restore natural functions to improve the state of EFH and related fishery resources.

The Council has adopted a definition of enhancement to classify all management measures that may protect or promote the development of EFH and fishery resources. This particular concept is closely associated with restoration efforts with more attention at establishing new habitat conditions to support a fishery resource. Such approaches may include the construction of artificial reefs that provide suitable environmental conditions for a variety of marine organisms. For example, projects underway in Narragansett Bay to use artificial reefs to provide protective cover for lobsters (*Homarus americanus*), and reseeding techniques to promote northern quahog (*Mercenaria mercenaria*) and Atlantic sea scallop (*Placopecten magellanicus*) development and growth. If data support findings that enhanced habitat conditions increase the productivity of EFH, the Council may initiate habitat enhancement projects.

Rotational management may be an appropriate management technique that the Council
investigates to conserve and enhance EFH of particular species. Certain organisms may exhibit behavior and development patterns that would benefit from rotational management techniques. Rotational management is a multifaceted approach to manage fishery stocks. Issues to consider are designation of regions, duration of closures, pattern of rotation, economic impacts, and the growth rate of target organisms. Rotational management measures may be appropriate for sessile organisms such as the Atlantic sea scallop (*P. magellanicus*). The concept of rotational management is a potential method of conserving, enhancing, and protecting EFH. Other similar concepts include ocean zoning and alternation of closed areas.

*Integrated resource management* (Ehler and Basta 1993) is a theoretical concept that considers all levels of participation of the entire natural resource *a priori*. Management of multiple-use natural resources requires diverse activities such as planning, assessing, implementing, enforcing, monitoring, evaluating, and educating. These activities could be integrated and performed continuously to obtain maximum social, economic, and ecological benefits (Ehler and Basta 1993). The integration of economic sectors (e.g. fishery, agriculture, energy, and recreation), agencies (e.g. natural resource, environmental protection, economic development, and land-use departments), authorities (e.g. federal, state, regional, and local institutions), management tasks, and other disciplines (e.g. science, engineering and technology, economics, politics, and law) may promote the conservation and enhancement of EFH and related fishery resources (Ehler and Basta 1993).

*Education outreach* is an important component of the conservation and enhancement of EFH. Sharing information and educating resource managers, scientists, and the general public assist in general habitat protection. Promoting outreach may contribute to a high degree of community involvement and support of particular protection efforts and encourage the enhancement of EFH. Many state, federal, and non-governmental agencies promote healthy environments by outreach programs and may want to further develop and promote their particular programs. For example, the Stellwagen Bank National Marine Sanctuary may want to expand and enhance its public programs to emphasize the importance of habitat. Information available to all public and professional levels can promote and assist in the conservation of fishery resources.

### 6.5 EXISTING CONSERVATION AND ENHANCEMENT MANAGEMENT AUTHORITIES AND RESEARCH AND MONITORING PROGRAMS

The Council will work closely with a variety of management authorities and non-profit organizations to incorporate EFH designations into existing initiatives and future management decisions, promote EFH awareness, develop measures to conserve and enhance EFH, and enforce existing conservation and enhancement measures. Research and monitoring programs present the opportunity to provide scientific information to the Council that may be useful for making defensible management decisions. The following overview of existing agencies and programs represents potential partners that the Council will cooperate with to incorporate EFH into their respective programs and decision making processes (reviewed in *Water Quality Guidance for EFH Amendments*, NOAA).
6.5.1 Federal Programs

The Department of Commerce (DOC) is responsible for managing marine fisheries in federal waters. The Secretary of Commerce delegates this responsibility to the National Oceanic and Atmospheric Administration (NOAA). NOAA derives its authority for the conservation and enhancement of fishery resources, including habitat, from several sources and partially delegates responsibilities to other federal agencies.

The Coastal Zone Management Program (CZMP) is administered under the Coastal Zone Management Act of 1972. Objectives of the CZMP include protection of natural resources, life, and property from coastal hazards, public shorefront access, and consultation and coordination with federal agencies. For example, many participating states are developing or have developed coastal non-point source pollution control programs, established under section 6217 of the Coastal Zone Management Act Reauthorization Amendments of 1990 (CZMA), that are approved jointly by NOAA and the Environmental Protection Agency (EPA). Once the federal government has approved a state’s coastal management plan, the state is eligible for federal grants and technical assistance to implement the plan. The CZMA includes the restoration of coastal resources as a program goal.

Several other programs are administered directly under NOAA’s authority. The National Status and Trends program determines current status and detects changes in environmental conditions of estuarine and coastal waters. The Mussel Watch and Bioeffects Survey Projects are examples of monitoring programs designed to protect habitat under the Status and Trends program. The Estuarine Eutrophication Survey is a national assessment of the status of estuarine eutrophication and develops a national Estuarine Trophic Index to assist in the conservation of habitat. The Coastal Intensive Site Network (CISnet) provides long-term data on eutrophic conditions and effects on ecosystems. The National Coastal Pollutant Discharge Inventory (NCPDI) produces data characterizing pollutants from point and non-point sources in estuarine drainage areas. The Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) program initiates research on nutrient concentration and cycles in estuarine and coastal waters to explain associations between nutrient input and HABs. Indicator Development programs develop habitat condition bioindicators to measure the health of fish habitats. The Habitat Research / Restoration program develops and promotes research to address ecosystem function, alteration, restoration, indicators, and synthesis and information transfer. The National Estuarine Research Reserve System (NERRS) monitors water conditions and manages data of particular estuarine habitats. Within New England, there are NERRS sites in Wells, Maine, Waquoit Bay, MA, Great Bay, NH, and Narragansett Bay, RI.

The National Sea Grant College Program, administered under NOAA, provides expertise on a variety of environmental issues and educational outreach to public. The Sea Grant Program was established in 1966 to hasten the development, use, and conservation of the nation’s marine and Great Lake’s resources (based on National Sea Grant College mission statement). The Sea Grant Program is active in research and general conservation and enhancement projects throughout the U.S.
NOAA also derives regulatory power with habitat implications from the National Marine Sanctuaries Act (NMSA). The NMSA developed the National Marine Sanctuaries Program (NMSP) and authorizes further fishery resource regulations should measures be necessary to address specific problems at a particular sanctuary. Sanctuaries in the NMSP are managed by NOAA’s Sanctuaries and Reserves Division of the National Ocean Service Office of Ocean and Coastal Resource Management. The NMSP has direct authority to mitigate habitat-related threats within identified sanctuaries. The NMSA also empowers NMSP to develop direct measures to conserve and enhance habitat within sanctuaries. The Stellwagen Bank National Marine Sanctuary was designated off the coast of Massachusetts in federal waters in 1992.

NOAA's National Undersea Research Program (NURP) is an agency created to provide scientists the capability to conduct in situ research. To understand the ocean environment and to clarify the complex interrelationships within the environment and between humans and environment, it is often necessary to place scientists under the sea at the actual site of investigation (in situ). NURP is involved in several projects and initiates research that promotes the protection, conservation, and enhancement of habitat and living marine resources.

The Cooperative Marine Education and Research (CMER) Program is a cooperative agreement administered through NOAA and academic institutions. This program combines NOAA and academic expertise to address marine issues affecting local, regional, and national natural resources. Several cooperative research projects throughout the nation directly promote the conservation of habitat, and many other studies investigate general marine resource issues. The CMER Program is a substantial source of funding for the cooperative institutions and participating students, faculty, and staff.

The National Marine Fisheries Service (NMFS) is the agency of NOAA that has the responsibility and authority to conserve and enhance living marine resources and their habitat. NMFS conducts research and provides services and products to support fisheries management, fisheries development, trade and industry assistance, enforcement, and protected species and habitat conservation programs. The NMFS Habitat Conservation Policy established the guidelines to assess habitat issues pertaining to managed species. This policy strives to protect, conserve, restore, and create habitats important to self-sustaining populations of fishery resources. To further the conservation and enhancement of EFH in accordance with section 305(b)(1)(D) of the Magnuson-Stevens Act, NMFS will compile and make available to other federal and state agencies, information on the locations of EFH, including maps and/or narrative descriptions. NMFS will also provide information on ways to improve ongoing federal operations to promote the conservation and enhancement of EFH. Federal and state agencies empowered to authorize, fund, or undertake actions that may adversely affect EFH are encouraged to contact NMFS and the Council to become familiar with areas designated as EFH, and potential threats to EFH, as well as opportunities to promote the conservation and enhancement of such habitat.
The NMFS’s Restoration Center is another initiative that promotes restoration of coastal and estuarine habitats. The Center serves NOAA, other federal agencies, state and local governments, and works with non-governmental organizations, schools, and private industry. Objectives of the Center include restoring fish habitat and other natural resources that have been adversely impacted by human activities, advancing the science and technology of coastal habitat restoration, and transferring restoration technology to the public, the private sector, and other governmental organizations.

The Restoration Center is a part of NOAA’s Damage Assessment and Restoration Program (DARP) through which NOAA claims damages for adverse impacts to marine resources resulting from oil spills, hazardous releases, or other human-induced environmental disturbances. Parties responsible for the degradation of habitat provide funds or conduct projects to restore, replace, or acquire the equivalent of the injured resources. To date, this program has initiated restoration activities at over 25 locations around the country. The Center also administers grant programs to foster community-based habitat restoration projects to promote stewardship and conservation ethic among coastal communities and to fund research on restoration to advance science and technology. Over the past two years, 13 community-based and 16 research grants have been awarded. The Restoration Center has demonstrated the effectiveness of habitat restoration for countering human impacts on the marine environment.

NMFS provides a variety of consultative services to regulatory and construction agencies, developers, and the general public to promote methods to lessen and avoid human-induced threats or unavoidable habitat loss or degradation. NMFS serves as a federal trustee to oversee and ensure the restoration of marine habitats damaged by human activities and unforeseen events. NMFS is the primary enforcement regulatory agency for the protection of marine resources in federal waters. NMFS programs relevant to habitat conservation and enhancement are derived from several acts including the Marine Mammals Protection Act, Endangered Species Act (shared responsibility with U.S. Fish and Wildlife Service), Marine Protection, Research and Sanctuaries Act, Fish and Wildlife Coordination Act, and National Environmental Policy Act (review agency in the consultation process).

The U.S. Environmental Protection Agency (EPA) authority on habitat issues stems from several sources. The Clean Water Act (CWA), Section 102, 305, 319, 401, 402, and 404, directs the EPA to address and mitigate habitat problems and groundwater contamination through several programs and state support. Specifically, the EPA is dedicated to addressing the environmental considerations of polluted run-off and established the National Pollutant Discharge Elimination System (NPDES). The NPDES permit contains three major elements; (1) water quality limitations and monitoring requirements, (2) operating conditions and best management practices, and (3) environmental programs. The National Environmental Policy Act requires a full Environmental Impact Statement for proposed projects to be reviewed by the EPA and other consultation agencies.

The EPA also administers the National Estuary Program (NEP) under the CWA which
established a program to protect and restore the health of estuaries, while supporting economic and recreational activities. The NEP includes 28 estuaries along the coast of the U.S. and provides a source of coastal protection and to demonstrate practical, innovative approaches for protecting estuaries and their living resources. Within New England, there are six NEP sites, including Casco Bay, New Hampshire estuaries, Massachusetts Bay, Buzzards Bay, Narragansett Bay, and Long Island Sound. Along with NEP, the Environmental Monitoring and Assessment Program (EMAP) provides information on ecological conditions of the nation’s estuaries. EMAP is developing a national monitoring design and determining bioindicators to assess estuarine quality. The Food Quality Protection Act also authorizes EPA to assess current pesticide tolerances of marine and estuarine organisms by the year 2006.

The Safe Drinking Water Act (SDWA) authorizes EPA to ensure that water is safe for human consumption. EPA’s primary initiative to ensure clean water for human consumption is to protect groundwater sources. Protecting groundwater directly protects natural resources and is achieved through the following SDWA programs; the Source Water Assessment Program (ensures that states assess drinking water quality), the Wellhead Protection Program, the Sole Source Aquifer Program, and the Underground Injection Control Program. The Resource Conservation and Recovery Act (RCRA) is part of the EPA’s overall program to protect groundwater resources. RCRA addresses issues related to the development of regulations and methods for handling, storing, and disposing hazardous material. EPA also operates several programs through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Act of 1986 that protect and restore contaminated groundwater.

The Department of Agriculture (USDA) has authority to develop and promote conservation and enhancement measures through the Natural Resources Conservation Service (NRCS) and the Forest Service. The 1996 Farm Bill authorized the NRCS to promote a community-based approach to environmental improvement. A number of programs implement various projects to conserve habitat (i.e. Water Quality Program, Conservation Reserve Program, Snow Survey and Water Supply Forecasts, Wetlands Reserve Program, etc.). The Forest Service oversees all forestry activities on public lands and within the forestry industry. Current activities include protection of riparian areas, restoration of stream corridors, reclamation of abandoned mines, re-licensing hydropower facilities, etc. Under the Forest Service, the Agricultural Research Service implements research in order to lessen the effects of agricultural non-point pollution that can indirectly impact EFH.

The Department of Defense (DOD) delegates management authority to the Army Corps of Engineers (ACOE). The ACOE’s authority stems from Section 10 of the River and Harbor Act of 1899, the Clean Water Act, and the Marine Protection, Research, and Sanctuaries Act. The ACOE is involved with providing navigation, flood damage prevention, environmental restoration, wetlands protection, etc. The ACOE is also involved with several interagency reviewing and consultation processes.

The Department of Interior (DOI) is directly involved with conservation and
enhancement measures through a multifaceted approach. The DOI delegates authority to study, conserve, and enhance habitat to the Bureau of Land Management (BLM), Geological Survey (USGS), National Park Service (NPS), Fish and Wildlife Service (USFWS), and Bureau of Reclamation.

The BLM provides measures to conserve and enhance habitat through the Range Reform and National Riparian Initiative programs. The Range Reform program provides framework for improved watershed management through the development and implementation of the Standards and Guidelines of a community-based, management approach for each participating state. The Standards and Guidelines are meant to provide an efficient approach for watershed management decisions. The National Riparian Initiative program develops projects on the general improvement of wetland and riparian habitat.

The USGS is involved with the Federal-State Cooperative Program that implements water resource investigations including water quality assessment. The USGS also administers the National Stream Quality Accounting Network (NASQUAN) that monitors pollutant loads on the Mississippi, Columbia, Colorado, and Rio Grande Rivers with the potential to expand its monitoring range. The National Water Quality Assessment (NAWQA) Program, within USGS, collects and assesses information on current water quality conditions, changing water quality, and improved understanding of natural and human impacts on habitat.

The USGS focuses research on the geology of the marine environment and oceanographic processes that directly relate to fish habitat. USGS and NMFS have collaborated on several research projects that have investigated the relationship of fishery resources and habitat conditions. The research programs administered under USGS have and continue to assist in the identification of important environmental conditions for finfish and shellfish populations.

The National Park Service is directly involved with managing the nation’s parks through two programs. The Inventory and Monitoring Program monitors environmental conditions of existing parks, and the Integrated Pest Management Program limits the use of pesticides that pose great risk to the environment.

The USFWS is involved with many aspects of conservation and enhancement programs authorized under the Marine Mammal Protection Act, Endangered Species Act, Anadromous Fish Conservation Act, Fish and Wildlife Coordination Act, North American Waterfowl Management Plan, Watershed Planning and Protection Act, and Federal Power Act. The USFWS works in collaboration with federal and state agencies to develop programs to conserve and enhance fishery resources including the USFWS Fisheries Program that describes and monitors Atlantic salmon habitat in freshwater. Other initiatives that USFWS has developed directly to conserve and enhance habitat include the National Wildlife Refuge System and Partners for Fish and Wildlife Program to restore and protect wetlands and other freshwater habitats and the Contaminants Program to assess, remediate, and restore impacted habitats. The USFWS also works to
achieve and maintain fish passage facilities in several New England rivers.

The Bureau of Reclamation administers the DOI’s Departmental Irrigation Drainage Program. The objective of the program is to address areas of concern in western states of irrigation flow returns directly impacting Federally protected areas. The incentives of this program may migrate to the east coast of the U.S. with successful management accomplishments.

The Department of Transportation (DOT) authority is delegated to the Federal Highway Administration. The Federal Highway Administration’s authority to develop measures that pertain to the conservation and enhancement of habitat is derived under the Intermodal Surface Transportation Efficiency Act of 1991 that developed erosion and sediment control guidelines for states. The Surface Transportation Program also identifies methods and techniques of reducing highway run-off as eligibility for Federal-aid Highway financing. The DOT is indirectly involved with reducing run-off and controlling erosion and sedimentation in order to protect habitat, resulting in notable conservation and enhancement measures for marine and anadromous resources.

Interagency measures are an important sector of efficient conservation and enhancement programs. Specific examples of interagency efforts include a comprehensive document of technical information about management measures to prevent and reduce non-point source pollution in coastal habitats (e.g. The Guidance Specifying Management Measures for Sources of Nonpoint Source Pollution in Coastal Waters). The Guidance document is a collaboration between NOAA, EPA, USDA, USFWS, and several other federal and state agency experts. The Chesapeake Bay Program is another collaborative interagency effort. The Chesapeake Bay Program is worth noting because of the success of addressing environmental concerns within the Bay associated with point and non-point sources that are derived from several sources in a large region.

6.5.2 State Programs

The Coastal Zone Management Act (CZMA) of 1972 established a national policy to preserve, protect, develop, and where possible, to restore or enhance, the resources of the nation’s coastal zone and to encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone [16 U.S.C. 1452, Sec. 303 (1)(2)]. This federal law and many state and local acts have implemented and delegated authority to appropriate organizations and levels of government for the conservation and enhancement of coastal resources (CZMA Section 309 Enhancement Grants Programs are reviewed by Pogue et al. 1994).

The 1990 amendments to the re-authorization of the CZMA established a requirement for all state coastal zone management (CZM) programs to develop coastal non-point source pollution control programs. CZM programs have developed programs to monitor and assess sources of non-point pollution that may impact habitat.

Special Area Management Planning was also administered under Section 309 of the
Coastal Zone Management Act of 1972 as amended. This set up a process for awarding Coastal Zone Enhancement Grants to states to support the state’s development and implementation of their overall program objectives. Special Area Management Planning administers measures specifically designed to protect, conserve, and potentially enhance habitat conditions. Other specific management measures to protect submerged aquatic vegetation are reviewed in ASMFC Habitat Management Series #1 (Ernst and Stephan 1997).

Connecticut manages the coastal region of the Long Island Sound through the Connecticut Coastal Management Act (CMA). The CMA creates a single set of policies, standards, and criteria for all government levels in Connecticut to manage marine, estuarine, and riverine resources (Ernst and Stephan 1997). The lead agency that initiates and runs the coastal management program is the Connecticut Department of Environmental Protection. The main focus of Connecticut’s program is outreach and education on a variety of environmental and land use issues. Important habitat conservation issues identified by Connecticut cover five general issues: wetlands, public access, cumulative and secondary impacts, special area management planning, and coastal hazards (Pogue et al. 1994). Currently, Connecticut is involved in efforts to protect and restore Atlantic salmon in the Connecticut River.

The Rhode Island Coastal Resources Management Program (RICRMP) addresses the physical and organizational aspects of natural resources. The RICRMP requires a Category B permit for major activities in tidal and coastal pond waters, shoreline features, and adjacent areas. The permit directly and indirectly conserves coastal resources (Ernst and Stephan 1997). Rhode Island identified issues of wetlands, public access, special area management plans, and cumulative and secondary impacts as concerns for the conservation and enhancement of habitat. Specifically, NOAA, University of Rhode Island, and Rhode Island Department of Environmental Management are working in coordination on coastal restoration projects, including lobster habitat and quahog bed restoration in Narragansett Bay. The Narragansett Bay Critical Resources Mapping Project is another initiative to develop a critical resource inventory that would serve as the basis for a bay-wide approach to resource protection and restoration. The project evolved from a pilot mapping effort using donated equipment and staff time to a much larger federal and state grant funded effort to delineate and map eelgrass beds, salt marshes, and other coastal features. Several salt ponds, Providence Harbor, Pawcatuck River Estuary, and Narrow River are areas for which the RICRMP has special management plans.

The Commonwealth of Massachusetts has several levels of authority to conserve and enhance habitat. The major programs for which Massachusetts focuses effort are water quality, habitat, protected areas, coastal hazards, port and harbor infrastructure, public access, energy, ocean resources, and growth management. Massachusetts derives its authority for program policies through the Scenic Rivers Act, Mineral Resources Act, Massachusetts Environmental Policy Act, Massachusetts Endangered Species Act, Historic District Act, Public Waterfront Act, Massachusetts Clean Air Act, Massachusetts Solid Waste Management Act, Coastal and Inland Wetlands Restriction
Act, Wetlands Protection Act, Inland Wetlands Protection Act, and Ocean Sanctuaries Act. Examples of existing programs include the Wetlands Restoration and Banking Program (WRBP), GROWetlands Initiative, and Areas of Critical Environmental Concern Program.

The coastal habitats of New Hampshire are protected under the programs of the NH Department of Environmental Services. The Wetland Program derives its authority from the NH Code of Administrative Rules. Wetlands and cumulative and secondary impact issues are identified by NH as major environmental concerns (Pogue et al. 1994). Regulations include measures regarding dredge and fill activities and development in coastal regions. Coordination among the University of NH, Maine Department of Marine Resources, and NH agencies are mapping important submerged aquatic vegetation areas (Ernst and Stephan 1997).

The Maine Coastal Program sets priorities among the issues that coastal communities confront in their efforts to prosper economically, protect natural resources, and preserve quality of life. The Coastal Program derives its authority from 13 of the state’s environmental land use laws which pertain to air and water quality, construction near wetlands and along beaches, marine resources, solid waste sites, and land use planning and regulation (ME 1998). The land use laws include the Natural Resources Protection Act, Site Location of Development Act, and Municipal Subdivision Law, and Land Use Regulation Act. The Department of Environmental Protection is the primary regulatory agency. The Coastal Program’s priority issues are the impacts of development, ocean resources, aquaculture, and coastal economic development (ME 1998). Other important issues in which the Coastal Program is involved include public access, coastal hazards, coastal wetlands, port and harbor development, marine debris, and siting energy and government facilities (ME 1998). Program objectives to undertake these issues include identifying important coastal habitats, protection of wetlands from human activities, and assessing non-point sources of pollution (Ernst and Stephan 1997). Currently, Maine is involved in a cooperative effort to map coastal submerged aquatic vegetation (Ernst and Stephan 1997). An example of a specific program is the Shore Stewards Partnership Program that is Maine’s cooperative effort to conserve habitat through training volunteers to solve local water problems.

Vermont administers several habitat-related programs that could conserve and enhance freshwater habitats that may be important to Atlantic salmon populations. Other anadromous fishes may be protected by Vermont’s conservation and enhancement programs that may influence salmon populations.

The Atlantic State Marine Fisheries Commission (ASMFC) is a cooperative effort by the Atlantic coast states responsible for managing fishery resources that traverse state boundaries. The ASMFC has several policy statements and develops documents that directly promote and assist the conservation and protection of habitat along with enhancement and restoration initiatives to assist in management of fishery resources. The ASMFC assists in the habitat consultation processes with state and federal agencies.
An important objective for ASMFC is the conservation and improvement of marine fish habitat. The ASMFC approach for this objective includes policy development and education. Habitat policy development has focused on ensuring that habitat information and needs are clearly outlined in the ASMFC fishery management plans, and disseminated to the agencies with the regulatory authority to protect habitat. The ASMFC educational efforts complement the policy by providing additional information to fishermen and the general public, along with advice about what individuals can do to assist in the protection of fishery resources (Dunnigan 1997).

The ASMFC administers protection of fishery resources through fishery management plans and the Sport Fish Restoration Program. Fishery management plans regulate the harvest of transboundary fishes along the Atlantic coast. The Sport Fish Restoration Program is aimed at improving fishery conservation and wise utilization of critical sport fisheries resources of the Atlantic. The ASMFC role in this program is as a liaison between state and federal agencies and non-governmental organizations to promote interstate and state/federal cooperation on recreational fisheries programs (Dunnigan 1997). The ASMFC is currently developing an EFH policy very similar to the Council’s policy.

6.5.3 Non-Profit Organizations

Non-profit organizations can be very influential in management decisions to protect fishery resources. Several organizations develop programs to monitor and research habitat conditions and promote awareness of the importance of habitat conservation and enhancement. Commercial and recreational fishing groups have a vested interest in protecting habitat for sustainable fishing. A variety of organizations contribute to conservation and enhancement measures by providing valuable information on fishery resources. The following are examples of organizations that are currently or may become active participants in EFH issues:

- American Oceans Campaign
- Cape Cod Hook Fishermen’s Association
- Center for Coastal Studies
- Center for Marine Conservation
- Conservation Law Foundation
- Environmental Defense Fund
- Greenpeace
- New England Aquarium
- Gloucester Fishermen’s Wives Association / Gloucester Fishermen’s Association
- Maine Lobstermen’s Association
- Maine Sardine Council
- National Resources Defense Council
- National Audubon Society
- Massachusetts Audubon Society

6.6 DISCUSSION

Fishery managers, scientists, and the general public have discussed a variety of approaches to obtain sustainable fisheries for many years. Amendments 5 and 7 to the Northeast Multispecies Fishery Management Plan (NEFMC 1993 and 1996) discussed the issues regarding managing fisheries based on an ecosystem approach. Stock assessment is the conventional approach to promote sustainable fisheries, and the
methods for dealing with stock assessment uncertainty are widely accepted in the management community. The Council continues to base its decisions primarily on calculations of the impacts on catch (e.g. fishing mortality rate), and estimations of stock size and recruitment expectations. These approaches implemented by the Council are appropriate until overfishing is under control. As fishing effort becomes manageable, habitat issues will become particularly compelling.

The Council may consider the precautionary approach when making management decisions to protect fishery resources and their essential fish habitat. The precautionary approach states that where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation (Intergovernmental Agreement on the Environment 1992). Particularly, the precautionary approach may be applied to situations with high levels of uncertainty and a potentially irreversible fishing and non-fishing impact exists or is proposed. No single approach to manage fisheries on an ecosystem basis has yet emerged. The alternatives, however, present potential mechanisms to maintain and restore the productivity of the marine environment in the New England region.

The Council, federal and state agencies, and non-government organizations play key roles in protecting New England’s natural resources, particularly fishery resources and EFH. Organizations and interest groups assist in the conservation and enhancement of habitat with many actions from management measures that directly protect habitat to habitat-related research that assists with management decisions. The Council’s Essential Fish Habitat Amendment to existing fishery management plans promotes a greater awareness of the importance of habitat protection to all government and non-government agencies. The EFH designations, fishing impact assessment, non-fishing threats overview, and the conservation and enhancement recommendations can serve as a starting point to protect EFH for the sustainability of New England’s fishery resources.
7.0 RESEARCH AND INFORMATION NEEDS

The regulatory text of the Interim Final Rule directs the Council to include in the EFH amendment recommendations, preferably in priority order, for research efforts that the Council and NMFS view as necessary for carrying out their EFH management mandate. The need for additional research is to make available sufficient information to support a higher level of description and identification of EFH. Additional research may also be necessary to identify and evaluate actual and potential adverse effects on EFH including, but not limited to, direct physical alteration, impaired habitat quality / functions, cumulative impacts from fishing, or indirect adverse effects such as sea level rise, global warming and climate shifts, and non-equipment related fishery impacts. The need for additional research on the effects of fishing equipment on EFH is also included. The research needed to quantify and mitigate adverse effects on EFH identified in this amendment and determined to be an impediment to maintaining a sustainable fishery and the contribution of the managed species to a healthy ecosystem is identified.

The research recommendations include expanded life history information that will result in the comprehensive identification of the habitat requirements of the species or species assemblages, including all life history stages, as well as habitat-related information that defines the interrelationship between the species, the environment and the food web. The identified research needs also include information on adverse impacts from both non-fishing and fishing activities. Fishing activities include both recreational and commercial fishing equipment or practices.

The Council has conducted an initial inventory of available environmental and fisheries data sources relevant to the managed species (Table 5). This inventory should illumine major species-specific habitat data gaps. Only juvenile Atlantic cod has a level of information higher than Level 2. For example, the highest level of information available for some life history stages of many species managed by the Council is Level 0. Although not defined in the Interim Final Rule, Level "0" has been used to identify those areas where very little information exists, if any at all. Gaps in data availability (i.e., existence, accessibility, use and application of the data) and in data quality (including considerations of scale and resolution; relevance; and potential biases in collection and interpretation) are identified. The recommendations for basic life history information are intended to provide the Council comprehensive identification of the habitat requirements of the species, including all life stages, as well as habitat-related information that defines the interrelationship between the species, the environment, and the food web.

Implementation of the Magnuson-Stevens Act requires a program of research that provides information to support higher levels of description and identification of EFH. Research on the ecology of fish and their linkages with habitat is the foundation for such description and identification of EFH. The diversity, quality, and extent of habitats are among the most significant environmental determinants of distribution, abundance, and diversity of fishery resources. At present, the contribution of many of these habitats to the productivity of managed fishery species is unknown. Scientific information is required on the structure and function of fishery habitats to judge the impacts of threats and provide recommendations to protect and restore habitats.
In considering research and information needs, the Council hopes to integrate and coordinate as closely as possible with the NMFS Habitat Research Plan (HRP) (Thayer, G.W., J.P. Thomas, and K.V. Koski. 1996. The habitat research plan of the National Marine Fisheries Service. Fisheries 21(5) pp.6-10). The HRP provides a framework to conduct coastal and estuarine research and transfer results to those management components involved in permit reviews, development of habitat sections of FMPs and Protected Species Recovery Plans, and development of restoration options and plans as part of the Natural Resources Damage Claims. While not so stated, EFH is implicit in this plan. Under provisions of the Magnuson-Stevens Fishery Conservation and Management Act, the three tasks given to the Councils (identify and describe EFH; identify threats to EFH; and make recommendations for the conservation and enhancement of EFH) readily translate into four of the five research areas contained in the HRP:

- Research to identify EFH relates to HRP research area 1, "Ecosystem Structure and Function." Elements of the four-level process to describe EFH have been identified in the HRP.
- Fishing and non-fishing related threats to EFH relate to HRP area 2, "Effects of Habitat Alterations on Living Marine Resources."
- Conservation and enhancement measures, including restoration, relate to HRP area 3, "Habitat Restoration Methods."
- Research that is required to identify responses to degradation as well as ecosystem responses to conservation and enhancement measures relates to HRP area 4, "Indicators of Habitat and Living Marine Resources Degradation and Recovery."

The need for such a research program of coastal and estuarine research is not only mandated by the Magnuson-Stevens Act, but also was recognized by the National Academy of Sciences in their 1994 National Research Council Report on Priorities for Coastal Ecosystem Science which states that among the research areas requiring scientific information to eliminate shortcomings in our understanding of coastal habitat needs, functions, and processes are: relationships between habitat structure and function; recruitment and population and community development in both natural and restored ecosystems; processes that regulate and control interannual variability in populations; techniques, including the use of dredged material, for coastal habitat restoration; and, improved physical and biological models to help advance the design of ecosystem restorations.

The Council hopes to help direct NMFS habitat research priorities by identifying EFH research according to the five categories NMFS uses to structure its annual habitat research. Within these categories, the Council has identified a range of research and information needs from the short-term to the long-term.

- **Short-term** needs are defined as those which the Council believes will be required to meet the objectives of the EFH strategic plan within the five-year timeframe described in the plan.
- **Long-term** needs are defined as those the Council believes would be useful for improved habitat management, but probably will not be accomplished in the next few years and are not necessary for the Council to meet the immediate objectives of the EFH strategic plan.

The short-term and long-term designations reflect the Council's expectation that some types of needs can be met with information that already exists but that was not available to the Council for the current EFH process or information that could be obtained in the next few years. Although the Council has also attempted to provide the relative priorities of the needs, the designation of a need as either short-term or long-term is an implicit prioritization. Obtaining the information needed to meet the objectives of the Council's five-year plan is more important that obtaining the long-term type information.

### 7.1 ECOSYSTEM STRUCTURE AND FUNCTION

#### 7.1.1 Oceanographic Information

Water mass characteristics limit the distribution of fish and invertebrates on a regional scale, but fish react to their surroundings on a very fine scale. To assist fishery management, oceanographic work must help make the distinction between large scale features that determine the distribution of fish populations and the finer features that determine the movement of fish over fishing grounds.

**Long-term**

1. Model water masses and develop predictive capabilities for the movement of water masses.
2. Provide information on the effects of water mass movements on biological communities.

#### 7.1.2 Sediment Mapping Information

The general sedimentary structure of the New England shelf is known but the detailed distribution and extent of sediment types is only known in a few, relatively small areas.

**Short-term**

1. Undertake high resolution mapping of the most important sediments and topographic bedforms in areas of the Gulf of Maine, Georges Bank, southern New England, the mid-Atlantic, and their estuaries and bays.
2. The Department of Defense should make available to the Council and NMFS information it has collected on the sediment and biogenic structures and topographic bedforms of the Gulf of Maine, Georges Bank, southern New England, and the mid-Atlantic and their estuaries and bays.
7.1.3 Species Life History, Distribution, and Abundance Information

Life history information and data on abundance and distribution of fishes are basic to natural resource management. Although basic characteristics are known for many managed species, they are not known for all life history stages of all species.

Short-term

Existing Data and Information
1. NMFS should provide the Council with information on the landings of each Council-managed species, identified to the ten minute square from which they were harvested.
2. NMFS should homogenize / standardize the landings data (e.g., interview trips vs. non-interview trips).
3. Review and monitor federal and state historical databases for trends in abundance and distribution with an emphasis on unassessed species.
4. Investigate egg and larval data from power plant surveys to verify and possibly identify inshore distribution and abundance of these life stages.

Additional Biological Sampling -- This information is needed for all Council-managed species.
5. Enhance biological sampling to complete life history distributions and abundances of managed species in the New England region. Investigate habitats of the Gulf of Maine and Middle Atlantic Bight that currently are not sampled, but are likely habitat for important commercial species managed by the Council. Conduct biological surveys of continental slope habitats not adequately sampled for abundance and distribution of species occupying deepwater offshore habitats.
6. Provide information on species' distributions, relative abundance, habitat associations and habitat-related production rates. Develop consistent, high resolution, and standard survey techniques, such as used by Massachusetts in the Massachusetts inshore trawl survey, for all inshore areas not currently part of a sampling program.
7. Complement current surveys (i.e., bottom trawl, scallop dredge, MARMAP) with fixed, less intrusive gears (i.e., gill nets, fish pots) that may sample particular bottom types efficiently (i.e., ledges, deep crevices).

Species-Specific Needs -- Although general information is needed for all species (see above), NMFS identified the following specific needs for certain species.

Atlantic halibut
8. Information on the egg and larval stages of Atlantic halibut is very scarce. They have proven to be very difficult to catch in large enough numbers to be useful. More directed sampling effort, better sampling techniques, and better information about the location of spawning events are required. Data on these highly dispersive, pelagic stages are important to understanding recruitment and stock structure. Information on the migratory patterns of juvenile Atlantic halibut is lacking. It is believed that larger juveniles / sub-adults are highly dispersive, but no migration patterns have been shown. Mapping of size groups relative to habitat types (e.g., bottom type) based on groundfish survey catches would be of great benefit to describing EFH for Atlantic
halibut.

Haddock
9. A better understanding of the factors affecting haddock recruitment and year-class strength is needed. Research into obvious factors such as the effects of water temperatures, food levels, and predation on the survival of the early life history stages is needed. Also, the role of other factors such as hydrographic effects (e.g., tidal and non-tidal currents) which affect the retention and transport of eggs and larvae should be investigated more thoroughly. Interactions with other closely related species (e.g., cod) are most likely important, and could be better understood. Detailed information on spawning is needed, the NMFS literature search uncovered very few spawning details, other than the fact that spawning occurs at the bottom over gravel substrate.

Pollock
10. Many details of the biology of northwest Atlantic pollock are not well known. No information is available on the locations of spawning event. This is important information for understanding or modeling EFH.

Red hake
11. Red hake spawning grounds and their habitat characteristics should be more precisely defined. A cost-effective way to separate and identify the eggs of various Urophycis spp. found in the northeast is needed to better define what habitats support the eggs of each species. The occurrence and habitat use of red hake larvae in shallow coastal areas of the Gulf of Maine needs to be further assessed.

White hake
12. Need details on the spawning of white hake, especially where and when, and their habitat requirements. Need information on the distribution of white hake eggs and larvae. Need better identification of white hake eggs and larvae. Need information on the habitat requirements for white hake eggs, larvae, and juveniles. Need to understand the movement of white hake juveniles in pelagic stage to estuaries. Need information on locations and requirements for residency of white hake juveniles in demersal stage in colder months.

Windowpane flounder
13. Better information on windowpane flounder spawning times and locations (e.g., spring adult aggregation in Nantucket Sound and other major estuaries) and spawner habitat requirements (e.g., high salinity) is needed. Studies (e.g., tagging) to determine seasonal usage of estuaries and nearshore coastal waters are needed.

Winter flounder
14. The different components of the winter flounder stock complexes need to be better described and their habitat preferences need to be documented.

Witch flounder
15. There are no details in the existing literature on the specific nature of witch flounder spawning.

*Atlantic sea herring*

16. Need better information on distribution and abundance of herring larvae. Need more complete assessments of areas important for herring spawning which consistently support herring egg beds.

*Atlantic sea scallops*

17. Existing information on recruitment processes (i.e., which beds are self-sustaining and which are not) for Atlantic sea scallops is rather vague. Relatively little information exists since the identification of planktonic sea scallop larvae in the wild was not possible until quite recently. New genetic techniques make it possible to track the movement of larvae, providing very detailed information about recruitment processes. Better information on the effect of environmental variables on growth, survival, and production is needed. There is close to no information on the scallop egg stage in the wild; what is known is restricted to morphometrics and fecundity. More data on the duration of the egg stage, mortality rates, predation and substrate effects are needed. Within scallop beds, examine density dependent effects on growth, maturation, fecundity, and survival.

**Long-term**

18. Develop models based on small-scale studies to extrapolate to population level interactions.

19. Explore new technologies, e.g., acoustics or laser illumination, for improving surveys of all life stages.

### 7.1.4 Species Habitat Relationships

The relationship between habitat and fishery production is inferred as part of the designation of EFH. Identifying the critical factors and quantifying this relationship is in the very beginning stages of research. Although there are specific information needs identified for certain species, the following information is needed for all species.

**Short-term**

1. Life history-stage specific information on growth and survival rates by habitat type (i.e., Level 4 information) is needed to accurately designate EFH for all species.

2. Develop and test laboratory and field techniques to measure habitat-specific survival, growth, reproduction, and production rates. Conduct habitat related growth and maturity investigations and food habitat studies using new technologies such as stable isotope and insulin-like growth factor analysis. Examine genetic parameters such as presence of rare alleles to determine the reproductive value of different habitats for major managed fish species. Examine the utility of using molecular genetics, biochemical and tissue indices of energy status of selected species as indicators of habitat quality. Conduct research on the growth and metabolic rates of larval and
juvenile fishes as a function of salinity, temperature and habitat type.

3. Identify primary cues (e.g., temperature, salinity, turbidity, habitat structure, habitat location or quality and prey abundance) used by larvae and juvenile of commercially important fishery species for recruitment from oceanic spawning areas to coastal and estuarine habitats using remote sensing and field surveys. Identify factors regulating utilization of emergent and submergent habitats using field surveys, remote sensing, and such approaches as stable isotope analysis. Determine the importance of hydrographic, biotic, and structural components of the environment to the growth and survival of young of the year managed species that recruit to offshore banks. Identify sources and sinks of managed species’ production throughout the region, including identification of the origins of spawning adults and the fate of offspring spawned in various aquatic habitats within a region.

4. Identify and describe the biogenic structure associated with physical habitats.

5. Growth and survival rates by habitat (Level 3) and production rates by habitat (Level 4) are necessary to better identify EFH for all species.

6. The role of seafloor habitats on the population dynamics of fishes. While there are often good time series data on late-juvenile and adult populations and larval abundance, there is a general lack of empirical information on linkages between habitat and survival, which would allow modeling and experimentation to predict outcomes of various levels of disturbance.

7. Focus research on quantifying the mortality of species associated with habitat loss and alteration, contamination by toxics and power plant entrainment and impingement, as is being done for winter flounder. Determine if results of winter flounder studies are indicative of effects on other species and can be extrapolated to understand the effects on other species.

Atlantic cod
8. How many weeks do juvenile Atlantic cod reside on gravel during the eastward drift to sand habitats on the southeastern part of Georges Bank?

Ocean pout
9. The potential role that ocean pout may have in creating or expanding sheltering habitat, by burrowing or evacuating crevices and holes, for other species needs more research. The effect of intensive trawling on the persistence and use of these ocean pout created habitat modifications is also worth study. The means to assess ocean pout's use of reef-like habitats, where the species can readily avoid trawls, are needed to better characterize the relative value of all habitats used by the species at post-larvae life stages.

Pollock
10. The importance of inshore areas, specifically rocky subtidal and intertidal zones and salt marshes, as nursery areas of juvenile pollock requires more study. A better understanding of the role of these areas to recruitment and year class strength is needed to determine if these habitats are critical bottleneck areas.

Red hake
11. The use and relative importance to juvenile red hake of other sheltering habitats besides scallop and clam shells needs to be better defined. Do scallop and ocean clam dredging affect the habitat value of shellfish beds for juvenile red hake (and juveniles of other species)? The construction of sediment depressions by adult red hake for shelter or ambush-feeding (and the reuse of these depressions by other species) and the effects of intensive trawling / scallop dredging on the use of these shelters needs study.

Winter flounder
12. Conduct studies of winter flounder populations in impacted areas to fully quantify physiological adaptation to habitat alteration, and interactive effects, on an individual and population level.

Witch flounder
13. Information on growth and survival rates by habitat type is lacking, as are data to support theories of habitat use by the different life stages of witch flounder.

Atlantic sea scallop
14. Do young sea scallops survive best on gravel substrate and on non-mobile sand? Are young sea scallops (attached to the bottom) buried by sand moved by tidal and storm currents? Are sea scallops more abundance on disturbed gravel than on undisturbed gravel? If so, why? Does limited dredging benefit sea scallops by: (1) removing sea scallop predators; (2) removing competitors for food; (3) recycling buried food particles; or, (4) other factors?

Long-term
15. Determine the appropriate scale for resolving features of habitat and communities suitable for management for each habitat type. This work requires determining the appropriate physical parameters needed for characterization of each habitat type.
16. There is anecdotal evidence that clay pipes are rich groundfish habitat, and that historical clay pipe habitats have been destroyed by trawling and dredging. Determine actual utility of clay pipe habitat and effects of mobile fishing gear. Clay pipe habitat will not recover naturally; is it possible and advisable to restore and expand this habitat by emplacing artificial clay pipes made of other materials in areas where this habitat traditionally occurred?
17. Fresh blasted rock from the Ted Williams Tunnel excavation in Boston Harbor, Massachusetts, was disposed in the Massachusetts Bay Disposal Site region in 1992 - 1993. Rocks were disposed on sandy gravel habitat and on mud habitat. Rock piles are now utilized by lobsters and redfish. How do the rock piles compare in productivity with the natural sea bed in this region? How do the rock piles on mud bottom compare in productivity with the rock piles on sandy gravel bottom in this region? If more rock needs to be disposed in this region, where should it go and how should it be deposited?
7.1.5 Predators-Prey Relationship Information

Stomach contents data exist for many of the fish occurring along the New England shelf. Incorporating this into more than descriptive accounts of who eats whom has not yet been done.

Short-term

Ocean pout
1. The diets of larval and early juvenile ocean pout needs to be better known to more fully understand the function of the habitats they use. The interactions between ocean pout and other species that use or compete for the seasonal shelter used by ocean pout needs study, especially the interactions that influence the survival of some species.

Pollock
2. Information on predation of the various life history stages of pollock is lacking, and data on species interactions in general are needed.

Red hake
3. Is the degree of cannibalism associated in any way with larval / juvenile red hake habitat quality or quantity (i.e., shelter availability)?

Witch flounder
4. Little is known about the effects of predation on witch flounder, as well as interactions with other species in general.

7.2 Effects of Habitat Alterations on Living Marine Resources

7.2.1 Fishing Related Impacts

The ultimate goal of research on fishing impacts is not to retrospectively evaluate what fishing does to the environment but to predict cause and effect given a particular management protocol.

Short-term

1. Information on the recovery rates of the various habitat types following fishing activity in inshore and offshore waters.
2. Need information on the spatial extent of fishing-induced disturbance. While many observer programs collect data at the scale of single tows or sets, fisheries reporting systems often lack this level of spatial resolution. The available data make it difficult to make observations, along a gradient of fishing effort, in order to assess the effects of fishing effort on habitat, community, and ecosystem level processes.
3. Need to assess the effects of specific gear types, along a gradient of effort, on specific habitat types. These data are the first order needs to allow an assessment of how
much effort produces a measurable level of change in structural habitat components and associated communities.

4. NMFS should add entry lines to the NMFS Vessel Trip Reports to expand description of gear size and type used to harvest catch (i.e. chains, cookies, rock-hopper, etc.).

5. NMFS should provide the Council with effort data on the use of the various fishing gear types, tagged to the ten minute square in which it was used.

6. The appropriate entities (i.e., fishing industry, academia, NMFS, states, etc.) should conduct comparative studies of roller, rockhopper, chain, brush sweep, and other bottom-tending trawl gear (not including scallop dredges) to assess habitat impacts as well as bycatch, efficiency, and other impacts. As part of this work, examine any available existing information (e.g., Massachusetts DMF films) on the effects of various gear types.

7. What kinds of habitats are most vulnerable to bottom-tending mobile fishing gear? What kinds of habitats experience repeated natural change? Are they less vulnerable to gear effects than other kinds of habitats? What is the relationship between vulnerability to natural events (e.g., storms) and vulnerability to fishing gear?

8. NMFS should provide the Council with high resolution data on fishing effort throughout New England and the Mid-Atlantic.


Long-term

10. How much time is required for hard bottom habitats to "recover" from disturbances from fishing gear and from storms, and how do these relate? Determine how to distinguish between the effects of human and natural habitat disturbance on the fishery and the effects of overfishing.

11. NMFS, state fisheries agencies and private, non-profit organizations (e.g., Center for Marine Conservation) should sponsor continued research into fishing gear and practices that reduce marine debris, including the use of biodegradable materials.

12. Determine / monitor cumulative nature of fishing-related impacts.

13. Investigate other fish collection processes (i.e., fish wheels). New England fisheries are dominated by only three gears.

Aquaculture

Research on cultivating marine organisms in the wild (i.e. Seastead Site) and inland is an important aspect of managing the culture fishery. The following topics are areas of research to consider during the development of the culture fishery to lessen possible habitat impacts:

14. Direct impacts of particular aquaculture protocols on specific habitat qualities, particularly the impact of water-based culture facilities on natural habitat processes and functions, should be investigated to ease habitat impacts.

15. Filtration of land-based culture systems can be developed further to lessen potentially harmful discharge. Efficient filtration techniques to remove by-products (i.e. nutrients, feed additives, contaminants, etc.) from effluent can reduce potential impacts associated with aquaculture. Development of filtration techniques that
require less water or reuse more water will assist in reducing pressure on a clean water supply and lessen the amount of discharge. Techniques to use aquaculture filtration to cultivate seaweed or to use effluent as fertilizer may lessen the amount of discharge.

16. The life history requirements of marine and aquatic organisms are broadly known for an array of species. Further research is needed to improve the quality and quantity of information on life history requirement to increase aquaculture production through efficient rearing techniques. Nutritional requirements of reared organisms is an important aspect to investigate to develop efficient feeds to reduce uneaten and unassimilated feed entering the environment.

17. Aquaculture facilities continuously deal with disease outbreaks. Research on how to control or reduce the risk associated with disease episodes can potentially lessen the threat of reared organism disease outbreaks spreading to the wild.

18. Environmentally safe aquaculture may occur with continuing research on the development of alternate methods and practices of culturing organisms. Determining the carrying capacity of particular locations may provide aquaculture with higher production and more effective management decisions. Improvements in biological management strategies and engineering technologies may reduce environmental risk and increase productivity (USDA 1998). Facility design and technology needs to be researched to lessen potential environmental impacts, such as escapees, disease transmission, and harmful discharge.

19. Technological developments in aquaculture should be monitored to track the advancement of the industry and address potential environmental problems and solutions.

20. The different permitting and monitoring requirements provides some difficulty for aquaculturists. Addressing the differences in permitting and monitoring requirements for the variety of species cultured and location of cultivation, may assist in effective management measures.

### 7.2.2 Non-Fishing Related Impacts

Fishing is the most obvious impact on our fishery resources but there are many non-fishing related factors that can influence the sustainability of these resources. Identification and quantification of these factors is an essential part of developing an ecosystem based approach to management. The Council provides the following as general guidance on the types of information that would be valuable to our EFH process and habitat management program.

**Long-term**

**General**

1. Identify the effects of watershed management practices (such as regional comparisons of system responses to silviculture, agriculture, and urbanization) on maintaining the quality and quantity of essential fish habitat.

2. Develop better methods to use coastal change analyses to document and track changes in habitat types, structure, and quantity. Use this information to determine any trends directed at particular EFH.
3. Improve our knowledge of the nature and degree of pollutant effects upon marine organisms, particularly how they affect the capacity to survive and reproduce (growth rates).

4. Determine and monitor the synergistic or cumulative nature of non-fishing related (anthropogenic) impacts on habitat health.

5. Determine the relative impacts of different land use practices on coastal essential fish habitat functions and values.

6. Determine the extent of degradation of salt marsh habitat from tidal restriction and the rate of habitat loss from dredge and fill activities.

7. Determine the response of mud flat habitats to discharge and dumping.

8. Conduct studies of fish populations in impacted areas to fully quantify physiological adaptation to habitat alteration, and interactive effects, on an individual and population level.

*Heavy metals, etc.*

9. Some research questions include the impact of chronic levels of toxics at the population level, the spatial distribution of toxics outside of a few intensively monitored urban harbors, the persistence and turnover of different toxics within the sediments, and the exchange of toxics between the sediments and water column.

10. There also needs to be experimental studies to develop innovative methods of disposing contaminated dredge spoils and recovering toxics from dredge spoils to avoid degrading essential fish habitat.

11. Investigate decontamination techniques for dredged material / sediment / sewage sludge.

*Chlorine*

12. Research needs to be carried out on the impact of chlorine, dechlorinating agents, and chlorine derivatives on important marine organisms, such as eelgrass, kelps, lobsters, etc.

*Nutrients*

13. Identify sources of nutrients (e.g. septic systems) likely to impact EFH.

14. Verify models used to predict nitrogen sensitivity with some actual field studies of particular embayments.

15. Determine the transformations, if any, of nitrate and other forms of nitrogen in groundwater.

16. Examine the impact of different landscapes as source of nutrients to coastal waters within a watershed context.

17. Determine the role of coastal wetlands as sources and sinks for nitrogen.

18. Examine the impact of nutrients on algal community structure, including its potential role as a stimulator of red tide blooms.

*Exotic Species*

19. Targeted studies are needed to determine the ecological impacts of nonindigenous species that are most successful and threaten marine ecosystems and investigate whether there are any reasonable methods of controlling their introduction and spread.
20. There needs to be innovative techniques to eliminate the transport of nonindigenous organisms in the ballast water of ships.

**Harmful Algal Blooms**
21. Research is needed to enable better predictions to be made about the spread of toxic algal blooms from Maine throughout the rest of the Gulf of Maine. We also need to understand whether the severity of an algal bloom can be enhanced by passage through a relatively small area of elevated nutrients.

**Pathogens**
22. Research is needed on the links between pathogens of marine organisms and natural and human-induced environmental conditions.
23. Identify the long-term implications of pathogens entering the environment.

**Dredging and dredged material disposal**
24. Research should be carried out on the efficacy of capping as a technique for disposal of contaminated dredge spoils. Review capping protocols and operational constraints for effectiveness.
25. Investigate potential for toxicity and/or bioaccumulation of contaminants from in-situ and relocated marine sediments (before dredging and after disposal).
26. Determine the appropriate trigger levels for specific contaminants to predict bioeffects on Council-managed species.
27. Investigate the potential for bioremediation of contaminated sediments.
28. Critically evaluate temporal dredging windows to minimize adverse effects to Council-managed species during critical life stages and/or migratory patterns.
29. Review documented effects of disposed dredged material on essential fish habitats and associated benthic organisms and secondary productivity.
30. Develop a predictive model for evaluating the effects of volume and sediment quality.
31. Define salient geotechnical parameters for high capping efficiency and grain size.

**Artificial reefs**
32. NMFS and state fisheries agencies should sponsor research to investigate the impacts of artificial reefs on living resources, and determine if artificial reefs have beneficial effects on fish populations and therefore may enhance EFH.
33. The role that the expanding use of artificial reefs in the northeast plays in the relative abundance, distribution, and productivity of this seasonal, shelter-using, or possibly shelter-dependent needs to be evaluated.

### 7.3 HABITAT RESTORATION METHODS

**Long-term**

1. Develop habitat restoration design, monitoring and success criteria. Simulation modeling could be useful to vary design aspects for evaluation of temporal and spatial success rates.
2. Need to reach better understanding of the processes of natural recovery and
3. Develop hydrologic models to guide restoration of tidal flow.
4. Determine the conditions needed for successful habitat restoration and develop the best assessment methodology.

7.4 INDICATORS OF HABITAT AND LIVING MARINE RESOURCES DEGRADATION AND RECOVERY

7.4.1 Techniques to Mitigate Adverse Impacts

The challenge is not to eliminate fishing but to develop techniques and philosophies that are more compatible with habitat protection.

Short-term

1. Research into alternative fishing gear types that may have less adverse impact on some types of essential fish habitat.
2. Determine the influence of existing buffer zones on habitat functions and values. Determine the changes in buffer requirements needed to improve buffer zone effectiveness.

7.4.2 Habitat Conservation

Improving our ability to conserve existing habitat from further degradation is a critical part of the Council's habitat management program.

Long-term

1. Evaluate new and innovative techniques directed at assessing functional value and restoration success of anadromous fish habitat, restored saltmarsh, seagrass, and shellfish reef habitats throughout the region. Conduct comparative research on the impacts of urban development, agriculture, and silviculture on fishery habitats and evaluate restoration approaches that will include assessment of the role of buffer zones to ameliorate land use effects. Determine the importance of patch size and proximity to adjacent habitats in the development of restored habitats. Develop simulation models based on field evaluations of the functional development of restored habitats to provide management recommendations on the most cost effective design, approaches, and specifications for habitat restoration.
2. Evaluate the function and value of refugia relative to stock enhancement efforts and other management techniques for habitat conservation and protection.

7.4.3 Habitat Enhancement

There are natural limits to productivity but understanding what controls productivity may allow us to maximize fishery yield through habitat enhancement.
Short-term

1. Need to better understand "productivity" in the habitat sense and how overall productivity can be increased by habitat enhancement.
8.0 ESSENTIAL FISH HABITAT STRATEGIC PLAN

Recognizing that the Council's Essential Fish Habitat Amendment is just the first step in the management of EFH, and that the Council has more to do to fulfill the intentions and mandates of the Sustainable Fisheries Act, the Council has developed this Strategic Plan. The EFH Strategic Plan explains how the Council will fulfill the regulatory requirement to review and revise the EFH components of its fishery management plans within five years, and also provides a context and structure within which the Council will work. This Strategic Plan addresses the processes and actions of the Council for a five year timeframe following implementation of the EFH Amendment. The Strategic Plan also describes how the Council intends to disseminate the information that results from the EFH process to the federal and state agencies with a direct or indirect role in the conservation and management of EFH, or whose actions or activities have the potential to adversely affect EFH. The Strategic Plan describes how the Council will implement the Magnuson-Stevens Act provision that authorizes the Council to comment to federal and state agencies on actions that may adversely impact the habitat, including EFH, of fishery resources under its authority, and requires the Council to comment on actions that would substantially impact the habitat, including EFH, of anadromous fishery resources under its authority. The Strategic Plan consists of a goal statement for the Council's habitat program, a set of objectives for the Council's habitat program, and a description of the processes that the Council intends to implement to achieve the stated objectives.

Goal: Improve the quality and increase the productivity of New England's fishery resources through implementation of the habitat management program.

Objectives:

1. Refine the EFH designations for all Council-managed species by incorporating increasingly detailed information regarding the relative abundance, growth, survival, and production rates associated with different habitat types, including nearshore and estuaries (e.g., Level 3 and 4 information).

2. Designate additional HAPC's, as appropriate, to focus habitat management on areas particularly vulnerable to degradation, important for multiple species or critical to a particularly important life stage.

3. Improve our understanding and predictive capabilities of the effects of fishing activities and non-fishing related activities on EFH.

4. Improve our understanding and predictive capabilities of potential measures to mitigate activities that adversely impact EFH.

5. Develop and implement measures to minimize, to the extent practicable, any adverse impacts associated with fishing activities on EFH.

6. Provide recommendations to federal, state and local agencies and organizations
regarding proposed activities with the potential to degrade or eliminate EFH.

7. Improve our understanding and predictive capabilities of methods to restore and enhance productive fish habitat.

8. Develop and recommend to the appropriate authority measures to restore, conserve and enhance productive fish habitat.

9. Evaluate the Council's habitat program on a regular basis.

8.1  EFH REVIEW PROCESS

The regulatory text of the Interim Final Rule directs the Council and NMFS to periodically review the information in the EFH amendment and revise the EFH components of its fishery management plans if new information becomes available. The Interim Final Rule suggests that the schedule for this review should be based on an assessment of both the existing data and expectations of when new data will become available. Based on this guidance, the Council plans to conduct a complete review and update of EFH information and the EFH components of FMPs at least every five years. Rather than resubmitting an omnibus EFH amendment once every five years, however, the Council intends to implement the framework adjustment process described in this amendment and plans to "stagger" the revisions of the components of the EFH amendment as new or additional information becomes available.

The Council has reorganized its yearly schedule of Council meetings into a planned, topical, annual review cycle that allows for the most efficient review of new information and modifications of management. In April of each year, the Council will meet for two days to focus on habitat issues. At this meeting, the Council will review and consider the "Habitat Annual Review Report." This report to the Council will be developed by the EFH Technical Team and reviewed by the Habitat Committee prior to presentation to the Council. The report will include all new information related to the designations of EFH and HAPC, additional information on the effects of fishing activities, and an update on the status of the research and information needs identified by the Council. The Council will decide on a course of action based on the information provided in the report and direct the appropriate oversight committees to develop management measures necessary to protect HAPC and particularly vulnerable EFH. Depending on the issue and the relevant committee, proposed framework adjustment measures addressing EFH will be brought to the Council at either the July (herring), September (scallops), or November (groundfish and monkfish) meetings. Framework adjustments to modify the boundaries of EFH or HAPC could be brought to the Council by the Habitat Committee as early as the May Council meeting.

To support this process, the EFH Technical Team will meet on a regular basis throughout the year and will identify the information needed to prepare the annual report. The Council will request that NMFS and other appropriate agencies provide the required habitat-related information in a timely manner. The EFH Technical Team will meet to
discuss the information and develop recommendations to the Council regarding the information and suggested changes to the EFH and HAPC designations. The EFH Technical Team will also review any additional information available on activities that adversely impact EFH. Council staff will then develop the "Habitat Annual Review Report" and, following review by the EFH Technical Team and the Habitat Committee, submit the report to the Council for review and consideration. The annual review by the Council will focus on three areas: (a) EFH and HAPC designations; (b) identification of threats to EFH; and, (c) management measures to protect EFH.

8.1.1 EFH and HAPC Designations (Objectives 1 and 2):

In order to refine and improve the designations of EFH for all Council-managed species and to ensure that the appropriate areas are designated as HAPC's, the Council will work with NMFS and its other partners (state fishery agencies, state coastal zone management agencies, Stellwagen Bank National Marine Sanctuary, NOAA's National Ocean Service, National Undersea Research Center, etc.) to obtain and evaluate additional data sets (NMFS landings data, state inshore surveys, National Estuarine Research Reserve surveys, university research, power plant surveys, etc.). The Council will also work with the fishing industry to identify and evaluate additional information on important habitat areas. Using information from these various sources, the Council will work to refine the inshore EFH designations to a finer scale than the use of the ELMR salinity zones currently allows.

The Council will also consider the designation of HAPC's, as appropriate, based on the HAPC criteria described in the Interim Final Rule, and where the quantity or quality of a particular habitat type or area is directly linked to an ecological bottleneck for one or more species. The designation of HAPC's will extend, as appropriate, to areas or habitat types that are EFH for a vulnerable life stage of a significant number of Council-managed species or group of Council-managed species (i.e., flatfish, Gadidae, etc.). The Council may also participate in other activities focused on acquiring new and additional information necessary to meet the Council's EFH objectives. These activities may include workshops to develop the Council's priority research topics for improving EFH designations. The refinements of EFH and HAPC designations will depend to a large extent on the availability of the research and information proposed in the research and information needs section of the amendment.

8.1.2 Identification of Threats to EFH (Objective 3):

In order to better understand the adverse impacts of fishing and non-fishing related activities on EFH and to improve the Council's ability to predict threats to EFH, the Council will work with NMFS and its other partners (state fishery agencies, state coastal zone management agencies, Stellwagen Bank National Marine Sanctuary, NOAA's National Ocean Service, National Undersea Research Center, etc.) to obtain and evaluate the results of ongoing and future studies regarding the effects of various activities on EFH. The Council may also participate in other activities focused on acquiring new and additional information necessary to meet the Council's EFH objectives. These activities may include workshops to develop the Council's priority research topics for identifying
threats to EFH.

8.1.3  Management Measures to Protect EFH (Objectives 4 and 5):

The Council will work with NMFS and its industry advisors to develop and implement measures to minimize, to the extent practicable, the adverse impacts associated with fishing activities on EFH. The Council will also develop recommendations for other agencies (Mid-Atlantic Fishery Management Council, Atlantic States Marine Fisheries Commission, and state fishery agencies) to evaluate and minimize the effects on EFH of fishing activities under their jurisdiction.

8.1.4  Five-Year Plan (Objectives 1 - 5 and 9):

In year one (1999), it is not expected that much new information will be available to allow the Council to refine its EFH designations on a broad scale, but there may be additional information for Council consideration regarding some inshore areas, especially bays and estuaries. The Council may consider additional information regarding potential areas for HAPC designation. There also may be information for Council consideration regarding minimizing the adverse impacts to EFH or HAPC associated with certain types of fishing activity. The Council will implement any of these changes via the framework adjustment process.

In year two (2000), it is expected that the Council will review new and additional information with the goal of refining the EFH designations for several species, as well as considering information regarding minimizing the adverse impacts to EFH or HAPC associated with certain types of fishing activity. The specific species to be considered by the Council will remain indeterminate until the information becomes available.

In years three, four and five (2001 - 2003), the Council will review new and additional information with the goal of refining the EFH designations for the remaining species, as well as considering information regarding minimizing the adverse impacts to EFH or HAPC associated with certain types of fishing activity. During this time, the Council will also evaluate its habitat program and make changes to the program and this plan as appropriate.

8.2  CONSULTATION AND AGENCY RECOMMENDATIONS (OBJECTIVES 6, 7, AND 8):

The Magnuson-Stevens Act requires federal agencies to consult with NMFS regarding any of their actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect essential fish habitat. Upon approval of this EFH amendment by the Secretary of Commerce, federal agencies are required to complete this consultation process. The Council is encouraged to establish procedures for reviewing federal and state actions that may adversely affect the EFH of any species managed under its authority, and the Council and NMFS will cooperate as closely as possible to identify actions that may adversely affect EFH, to develop comments and
EFH conservation recommendations to federal and state agencies, and to provide EFH information to federal or state agencies.

The Council will fulfill its obligation under the Magnuson-Stevens Act regarding the EFH consultation process. When requested by the Regional Administrator, the Council will review the appropriate information and comment on activities that threaten EFH. The Council recognizes it has the authority to act independently, and there may be situations where the Council deems this necessary. In these cases, it will review the appropriate information and provide recommendations directly to the appropriate state or federal agencies. The Magnuson-Stevens Act requires that the Council review and comment on any activity which is likely to substantially affect the habitat of any anadromous fishery resource under its authority. In addition to Atlantic salmon, this includes species such as river herring, striped bass, and American shad. The Council plans to work closely with NMFS, U.S. Fish and Wildlife Service, the states, and the Atlantic States Marine Fisheries Commission to meet this obligation.

The Council and the NMFS Northeast Regional Office have developed an informal procedure for coordination in the review of federal agency actions that could adversely affect habitat. This is based on a procedure that has been in effect for several years between NMFS and the Mid-Atlantic Fishery Management Council (MAFMC) and has promoted successful collaboration on development projects of concern to both MAFMC and NMFS. Under this process, NMFS Habitat Conservation Division staff notify Council staff when NMFS learns of an action that could cause substantial adverse effects to the habitat of Council-managed species. NMFS reviews most actions that are authorized, funded, or undertaken by federal agencies in coastal and offshore waters, and federal agencies have been required to coordinate with NMFS on these projects under the Fish and Wildlife Coordination Act, so NMFS has an established mechanism for learning about projects that would adversely affect federally managed species.

Once Council staff are contacted by NMFS, they will request project-related documents from NMFS and may schedule a briefing on the activity at an upcoming Habitat Committee meeting. After the briefing, the Habitat Committee will consider adopting a motion for the Council to send a letter of concern to the appropriate parties. The Habitat Committee will then bring the issue to the full Council for approval. In the event that comment deadlines do not allow for the issue to be considered at a Committee and Council meeting, the Council Executive Director may send a letter of concern after coordination with the Habitat Committee chair and/or Council chair. To help NMFS provide information to the Council in the most efficient manner possible, the Council may work with NMFS to develop criteria to help NMFS identify the activities in which the Council is most interested. These criteria may take the form of an agreement with the NMFS Northeast Regional Office to promote coordination in the review of activities that may adversely affect EFH.

The Council will work with the appropriate federal, state, and local agencies and organizations to implement habitat conservation, restoration and enhancement measures and mitigate the effects of non-fishing related activities.
8.3 INFORMATION DISSEMINATION (OBJECTIVES 6 AND 8):

The Council will make every effort to provide up-to-date EFH information to all state and federal agencies whose actions or activities have the potential to adversely affect EFH. The Council plans to provide and explain the information in the EFH amendment (and future updates) to federal, state, and local agencies and organizations. To accomplish this, the Council will send copies of its EFH amendment to all federal and state agencies with a direct or indirect role in the conservation and management of EFH. The Council will also send letters to these agencies highlighting the habitat conservation, restoration, and enhancement recommendations of the Council to the agency. To ensure that the agencies understand the nature and purpose of the recommendations and the EFH designations, as well as to provide details on the nature of the consultation process, the Council and NMFS will visit each New England state and invite state and federal agencies to attend a meeting to present the relevant EFH information and recommendations as well as to answer questions and attempt to develop a working relationship with the agencies.

In order to make the information contained in the EFH amendment useful, accessible, and easy to understand by state and federal agencies and organizations, the Council will work with NMFS and other potential partners (i.e., National Ocean Service, NOAA's Coastal Services Center, Island Institute, etc.) to develop a CD-ROM based computer product that supports a complete desktop EFH information system. This product could include an interactive mapping capability, such as ArcView, to allow users to quickly and easily determine if particular area(s) are EFH, and for what species. This product would allow users to access quickly the information supporting the EFH designations and it could include the species reports and information on impacts, etc. The development of this product would be targeted at the state and federal agencies interested in reviewing projects for potential impacts to EFH, but it could also be useful to others as an information tool. The Council may also participate in public events (i.e., Maine Fishermen's Forum, Coastal Zone conferences, etc.) to promote the conservation and enhancement of EFH.

8.4 EFFECTIVENESS MONITORING (OBJECTIVE 9):

The NMFS Office of Habitat Conservation is currently developing a computerized tracking system for the EFH consultation process. The system is based on a relational database that will contain information on each federal or state agency action on which NMFS comments regarding impacts to EFH. NMFS staff will enter data such as the project name, location, type of action, agency authorizing or conducting the work, managed species affected, habitat types affected, date consultation was initiated, type of consultation, EFH conservation recommendations provided by NMFS, whether a Council commented on the action, date of the federal action agency’s response, and whether the action agency accepted all, some, or none of NMFS’ recommendations. NMFS will use this information to monitor the EFH consultation workload as well as the responsiveness of action agencies to NMFS’ recommendations to protect EFH. The system is based on
Lotus Notes software, and will allow frequent updates of data entered at NMFS headquarters, Regional Offices, and field offices, so consultations can be tracked by region, coast wide, or nationally. The system will also allow queries to monitor consultations with certain agencies or those that involve specific species, types of actions, etc.

The Council will strive to assess the effectiveness of its habitat program, including relating EFH activities, to the extent possible, with improvements in fisheries. This will, by necessity, be limited to a qualitative assessment. Whatever the apparent effectiveness of the Council's habitat program may be, there will always be many other factors that might contribute to the observed effects.
9.0 ATLANTIC SALMON FISHERY MANAGEMENT PLAN PROVISIONS

9.1 OVERFISHING DEFINITION FOR ATLANTIC SALMON

There is no overfishing definition in the Fishery Management Plan for Atlantic Salmon. Given the management measures that are included in the plan, the fishing mortality rate threshold (and therefore target) is zero, or as close as possible when taking into account discard mortality. There are no biomass thresholds, but there is a rebuilding target. The intention of the rebuilding effort discussed in the FMP was to increase the abundance of Atlantic salmon by 54,000 individuals and the Council expected this increase to occur within 25 years following plan implementation.

Evaluation: Although there is no formal overfishing definition and maximum sustainable yield (MSY) has not been estimated, the management strategy appears to be consistent with the Sustainable Fisheries Act and National Standard 1 Guidelines. Population biomass is probably well below \( \frac{1}{2} B_{MSY} \) (appropriate for a highly resilient stock) and \( B_{limit} \) (the biomass that can be rebuilt in 10 years or less). The carrying capacity of the Atlantic salmon stock should be re-established to determine whether 54,000 fish is a reasonable proxy for \( B_{MSY} \). The current estimate of abundance for native Atlantic salmon in U.S. waters is 200 fish.

9.2 AQUACULTURE FRAMEWORK ADJUSTMENT PROCESS FOR ATLANTIC SALMON FMP

9.2.1 Background

In August, 1997 the Council voted to amend all NEFMC fishery management plans (FMPs) to include a framework adjustment process that would facilitate the timely approval of aquaculture projects that would otherwise require a full plan amendment. Since the concept of approving aquaculture projects through frameworks is a new addition to the list of “frameworkable” measures already listed in several Council FMPs, the public must be given an opportunity to comment on this proposal. For the sake of efficiency, consideration of an aquaculture framework adjustment process has been added to the FMP amendments now being developed to bring all NEFMC plans into compliance with the Sustainable Fisheries Act.

Assigning a new purpose to measures that are part of a framework adjustment process requires adoption of a plan objective that is consistent with the framework action. For example, in the Multispecies FMP, the Council adopted a plan objective to reduce harbor porpoise bycatch in order to establish gillnet time/area closures through framework adjustments. Consequently, the following objective will be added to each FMP:

*To facilitate the siting of biologically and environmentally sound aquaculture operations in the EEZ, given that some projects cannot occur in federal waters without modification to one or more NEFMC fishery management plans.*
9.2.2 Process

The framework adjustment process that already exists in the Groundfish and Scallop FMPs allows the Council to modify specified plan measures more quickly than by preparing a full plan amendment. In those plans, the proposed modification is announced in advance of at least two Council meetings and public comments are taken at each of those meetings prior to a final Council vote on the issue.

Additionally, a document containing the measure(s) proposed, other alternatives under consideration and the biological and economic impacts of the measures is made available at least a week before the meeting at which the final vote is scheduled. If an action is approved, the Council forwards its recommendation to the National Marine Fisheries Service Regional Administrator (RA). If the RA concurs with the framework adjustment, he has the discretion to publish it either as proposed or final regulations in the Federal Register.

In the existing framework process, there are other factors which are weighed during consideration of an adjustment. They include: a) whether the availability of data on which the recommended management measures are based allows for adequate time to publish a proposed rule, and whether regulations have to be in place for an entire harvest/fishing season; b) whether there has been adequate notice and opportunity for participation by the public and members of the affected industry in the development of the Council’s recommended management measures; c) whether there is an immediate need to protect the resource; and d) whether there will be a continuing evaluation of management measures adopted following their implementation as a final rule.

For aquaculture projects in the EEZ, the Council’s recommendations on adjustments or additions to management measures must come from one or more of the following categories: minimum fish sizes, gear restrictions, minimum mesh sizes, possession limits, tagging requirements, monitoring requirements, reporting requirements, permit restrictions, area closures, establishment of special management areas or zones and any other management measures currently included in the FMP.

9.2.3 Rationale

The Council proposes the use of the above-described process to make necessary adjustments to Council FMPs which apply to EEZ-based aquaculture projects. The intent is to make changes to FMPs in a timely manner. During this process, the Council will address issues within its purview, including user group conflicts and fishery habitat-related issues, but will not pre-empt the role of the permitting agencies, the Army Corps of Engineers and the Environmental Protection Agency.
10.0 ACRONYMS AND GLOSSARY

10.1 ACRONYMS

ACOE  U.S. Army Corps of Engineers
ASMFC  Atlantic States Marine Fisheries Commission
$B_{\text{limit}}$  Biomass that can be rebuilt in 10 years or less
BLM  Bureau of Land Management
BMP  Best Management Practice
BMSY  Biomass needed to sustain Maximum Sustainable Yield
CERCLA  Comprehensive Environmental Response, Compensation, and Liability Act
CISnet  Coastal Intensive Site Network
CMER  Cooperative Marine Education and Research
CPUE  Catch-Per-Unit-Effort
CV  Coefficient of Variation
CWA  Clean Water Act
CZM  Coastal Zone Management
CZMA  Coastal Zone Management Act
CZMP  Coastal Zone Management Program
DARP  Damage Assessment and Restoration Program
DDT  Dichlorodiphenyl Trichloroethane
DOC  U.S. Department of Commerce
DOD  U.S. Department of Defense
DOI  U.S. Department of Interior
DOT  U.S. Department of Transportation
DPS  Distinct Population Segment
ECOHAB  Ecology and Oceanography of Harmful Algal Blooms
EEZ  Exclusive Economic Zone
EFH  Essential Fish Habitat
ELMR  Estuarine Living Marine Resources
EMAP  Environmental Monitoring and Assessment Program
EPA  U.S. Environmental Protection Agency
FMP  Fishery Management Plan
HAB  Harmful Algal Bloom
HAPC  Habitat Area of Particular Concern
ICES  International Council for the Exploration of the Seas
IUCN  International Union for the Conservation of Nature
MAFMC  Mid-Atlantic Fishery Management Council
MARMAP  Marine Resources Monitoring, Assessment, and Prediction
MDMF  Massachusetts Division of Marine Fisheries
MPA  Marine Protected Area
M-SFCMA  Magnuson-Stevens Fishery Conservation and Management Act
MSY  Maximum Sustainable Yield
NASCO  North Atlantic Salmon Conservation Organization
NASQUAN  National Stream Quality Accounting Network
NAWQA  National Water Quality Assessment
NCPDI  National Coastal Pollutant Discharge Inventory
NEFMC  New England Fishery Management Council
NEFSC  Northeast Fisheries Science Center
NEP  National Estuary Program
NERRS  National Estuarine Research Reserve System
NGO  Non-Governmental Organization
NMFS  National Marine Fisheries Service
NMSA  National Marine Sanctuaries Act
NMSP  National Marine Sanctuaries Program
NOAA  National Oceanic and Atmospheric Administration
NPDES  National Pollutant Discharge Elimination System
NRCS  Natural Resources Conservation Service
NURP  National Undersea Research Program
PAH  Polycyclic Aromatic Hydrocarbon
PCB  Polychlorinated Biphenyls
RA  Regional Administrator
RCRA  Resource Conservation and Recovery Act
RICRMP  Rhode Island Coastal Resources Management Program
SAV  Submerged Aquatic Vegetation
SDWA  Safe Drinking Water Act
SFA  Sustainable Fisheries Act
**USDA** U.S. Department of Agriculture
**USFWS** U.S. Fish and Wildlife Service
**USGS** United States Geological Survey
**UV** Ultraviolet
10.2 GLOSSARY

*a priori* ≡ Planned methodology.

*alevin* ≡ The period after the hatching of an Atlantic salmon egg when the salmon is entirely dependent upon the yolk sac for nutrition.

*anadromous* ≡ Referring to fish that breed in freshwater but spend most of their adult life in the sea.

*anoxia* ≡ Environmental conditions totally devoid of dissolved oxygen.

*aquaculture* ≡ Any activity that manipulates reproduction, spawning, feeding, settlement, growth, and development of marine or freshwater organisms; the controlled cultivation and harvest of aquatic animals and plants.

*aquatic* ≡ Referring to freshwater.

*ascidian* ≡ Another name for sessile tunicates; majority spend life attached to substrate, some free swimming.

*ballast water* ≡ Water within a ship to help maintain balance.

*bathypelagic zone* ≡ The water column between 1000 meters and about 4000 meters in depth.

*bedforms* ≡ Classifications of sediment structure.

*benthic* ≡ Pertaining to the seafloor environment; organisms living on or near the seafloor.

*bias* ≡ Samples taken from a population with a known parameter, should give sample statistics, which when averaged, does not give the parametric value.

*biodiversity* ≡ The variety of living creatures in a given area.

*biogenic* ≡ Of, relating to, or produced by a living organism.

*biomass* ≡ The number of individual organisms (in some area or volume or region) multiplied by the average weight of the individuals.

*biotic* ≡ Of, relating to, or produced by a living organisms.

*bioturbation* ≡ Disturbance of soft sediments by the movements and feeding activities of fauna.

*brackish* ≡ A mix of salt water and fresh water.

*bryozoan* ≡ Phylum Bryozoa. Sessile / colonial animals.

*bulkhead* ≡ A rigid vertical retaining wall built along a waterfront used to retain fill material or for erosion control.

*bycatch* ≡ Inadvertent catch of non-target organisms.

*carcinogenic* ≡ Substance that causes cancer.

*carrying capacity* ≡ The maximum population size that a given area or ecosystem can
support indefinitely under a given set of environmental conditions.

catchability ≡ The portion of a fish population in the path of fish gear which is caught and retained by a defined unit of effort.

channelization ≡ To provide a channel for.


conservation ≡ The rules, regulations, conditions, methods, and other measures which are useful in rebuilding, restoring, or maintaining, any fishery resource and the marine, aquatic, estuarine, or riparian environment.

contagious ≡ Clumped frequencies which have an excess of observations at the tails of the frequency distribution and consequently a shortage of observations at the center.

culvert ≡ A drain or conduit under a road or embankment.

cumulative impact ≡ The combined outcome of numerous actions and stresses which alone may have relatively minor impacts, yet add up to severe implications.

debris ≡ discarded material found within aquatic, estuarine, marine and terrestrial habitats.

demersal ≡ Pelagic species that live near the seafloor (see also epibenthic).

diatom ≡ Single-celled plant organism.

dissolved oxygen (D.O.) ≡ The amount gaseous oxygen within the water as measured in units (mg/l).

drilling mud ≡ Water- or oil-based complex and variable mixture of fluids, suspended solids, and chemical additives.

ecosystem ≡ A major interacting system that involves both organisms and the nonliving environment.

endocrine ≡ Hormone secreted within circulatory system of vertebrates.

enhancement ≡ Activities conducted in existing marine, aquatic, estuarine, or riparian areas, which improve one or more of the ecological functions and/or the biodiversity of existing, but degraded or impoverished, habitats.

entrain / impinge ≡ To catch or entrap.

epibenthic ≡ Referring to pelagic species that live in association with the seafloor.

epifauna ≡ Animals that live on, or attach to, a substrate surface.

epipelagic ≡ The upper region of the sea from the surface to about 200 - 300 meters in depth.

estuary ≡ a semi-enclosed body of water, positioned with a connection to the open ocean.

eutrophication ≡ Process whereby a body of water becomes enriched with nutrients, increases productivity, and accumulates organic debris.
evolution ≡ Genetic change in a population of organisms; in general, evolution leads to progressive change from simple to complex.

evolutionary significant unit ≡ A population of animals that is substantially reproductively isolated from other populations and represent an important component in the evolutionary legacy of the species.

exclusive economic zone ≡ Adjacent to state waters, which extend three miles out from the coast, the U.S. Exclusive Economic Zone includes waters from three to two hundred nautical miles from shore.

exotic ≡ Referring to non-native organisms; organisms which do not naturally occur; invasive species.

fauna ≡ The animal life of any particular area or of any particular time.

fish processing ≡ Cleaning, cooking, canning, smoking, salting, drying, or freezing of fish products. Preparing fishery products for market.

fishery management plan amendment ≡ A formal change to a fishery management plan. The Council prepares amendments and submits them to the Secretary of Commerce for review and approval. The Council also may change FMPs through a "framework adjustment process" (see below).

forage ≡ A search for food.

fossil fuels ≡ The altered remains of once-living organisms that are burned to release energy; coal, oil, and natural gas.

framework adjustment ≡ Adjustments to a fishery management plan within a range of measures previously specified in an FMP. A change usually can be made more quickly and easily by a framework adjustment than through an amendment. For plans developed by the New England Fishery Management Council, the procedure requires at least two Council meetings including at least one public hearing and an evaluation of environmental impacts not already analyzed as part of the FMP.

fry ≡ Life stage of salmonids; three to six weeks after hatching, after alevins stage, as it emerges from the gravel to seek food.

fungicide ≡ Chemical compound that kills fungus.

gravel lag ≡ Gravel areas (pavement) that are left behind and exposed after rising sea levels and other forces (e.g., glacial activity) erode sand ridges.

groin ≡ Series of small structures built perpendicular to the shore which extend from the beach into the surf zone to limit or prevent erosion.

gyre ≡ Circular current offshoot of a major current.

Hague line ≡ International boundary line between the United States and foreign countries.

halocline ≡ The zone of the ocean showing the greatest change in salinity with depth.

heavy metals ≡ Elements that present toxic effects to organisms.
herbicide ≡ A component designed to kill or limit the growth of non-woody plants.

hydroid ≡ Class Hydrozoa. The polyp form of a cnidarian, as distinguished from the medusae form.

hydrologic / hydrological ≡ Movement of water masses.

ichthyoplankton ≡ Finfish life history stage that occurs in the water column; egg and larvae.

impervious ≡ Incapable of being permeated by moisture.

impoundment ≡ A body of water unnaturally closed.

indigenous ≡ Native conditions.

inshore ≡ Coastal marine and estuarine environments, including rocky intertidal areas, exposed beaches, mudflats, salt marshes, seagrass flats, kelp beds, near-shore rocky bottoms, near-shore soft bottoms, tidal inlets, pelagic zone and other coastal habitats.

Interim Final Rule ≡ A federal regulation is usually published in the Federal Register as a proposed rule with a time period for public comment. After the comment period closes, the proposed regulation may be changed or withdrawn before it is published as a final rule, along with its date of implementation and response to comments. As an interim final rule, the regulation is available for an additional 60-day public comment period, and takes effect 30 days following publication in the Federal Register. Pending publication of a final rule, the regulations within the interim final rule are fully enforceable.

isobath ≡ A line on a map connecting points of equal depth of the seafloor.

jetties ≡ Structure built perpendicular to the shore at mouth of a channel or inlet, often used to protect a harbor or channel.

life history ≡ Development of an organism.

macroalgae ≡ Green seaweeds; often found in coastal waters.

marine ≡ Referring to saltwater environments.

marine protected areas (MPA) ≡ Any area of intertidal or subtidal terrain, together with its overlying waters and associated flora and fauna, and historical and cultural features which has been reserved by legislation to manage and protect part or all of the enclosed environment (4th World Wilderness Conference). Section 6.4.1.

maximum sustainable yield ≡ The largest annual catch that can be taken continuously from a stock without overfishing it under the present environmental conditions.

mesopelagic zone ≡ The water column from the bottom of the epipelagic zone to about 1000 meters in depth.

microflora ≡ Small / microscopic plant life.

mitigation ≡ A means of sequentially avoiding impacts, minimizing impacts, and compensating for remaining unavoidable impacts.
mortality = The rate at which fish in a population die from either natural causes (M = natural mortality rate) or from fishing (F = fishing mortality rate).

mutagenic = Genetic disruption in development.
natal stream = The birth stream of Atlantic salmon.
neritic = Pelagic waters of the continental shelf and inshore waters.
nonindigenous = Non-native environmental conditions or organisms.
non-point-source pollution = Pollution originating from a range of non-specific locations.
nudibranch = Shell-less gastropods.
nursery = Referring to areas that provide a level of predation refuge and nutritional requirements.
offshore = Open-waters, including habitat seaward of the inshore designation.
oil = Any hydrocarbon (e.g. polycyclic aromatic hydrocarbon) or petroleum substance.
ontogeny = The course of development of an individual organism.
organochlorides = e.g. polychlorinated biphenyls
palustrine emergent = Upland wetland habitat type characterized by abundant vascular plants.
parr = The period of the development of Atlantic salmon following the fry stage.
pathogen = Disease promoting or causing organism.
pelagic = Referring to the ocean water column and the organisms living therein.
pesticide = Compound designed to remove or limit the proliferation of an organism.
photosynthesis = The utilization of light energy to create chemical bonds; the synthesis of organic compounds from carbon dioxide and water.
phytoplankton = Autotrophic plankton.
Pleistocene = The period of geologic time of the last ice age.
point-source pollution = Pollution originating from a discrete, specific location.
Pomatomidae = The bluefish family; important recreational and commercial species.
potable water = Drinkable water.
precautionary approach = State where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation (Intergovernmental Agreement on the Environment 1992).
predation = The act of an animal feeding upon another animal.
pre-recruit = Life stage before fish reaches a certain size or age in a given year that is
harvestable.

**prop scarring** ≡ Physical damage to the seafloor and associated flora and fauna from the propeller of a boat.

**prop wash** ≡ The result of a ship propeller or impeller disturbing bottom sediments.

**pycnocline** ≡ The water layer in which density changes most rapidly with depth.

**radioactive waste** ≡ Radionucleides.

**recruitment** ≡ The addition of fish that reach a certain size or age in a given year, thereby adding to the fishable population.

**red tide** ≡ Generic name given to episodic algal bloom events; often giving water a reddish appearance.

**redd** ≡ A depression dug in the gravel by Atlantic salmon in which the eggs are laid.

**restoration** ≡ Re-establishment of marine, aquatic, estuarine, or riparian resource characteristics and function(s) at a site where they have ceased to exist, or exist in a substantially degraded state.

**riffle** ≡ A rocky shoal or sandbar lying just below the surface of a waterway.

**riparian** ≡ On, of, or pertaining to the bank of a river, or small lake or pond.

**riverine** ≡ Freshwater streams, rivers, and streamside wetlands including banks and associated vegetation that may be bordered by other freshwater habitats.

**salinization** ≡ The intrusion of saltwater.

**salmonids** ≡ Family Salmonidae.

**scrub-shrub** ≡ Upland wetland habitat classification of low-lying vegetation; bushes.

**seawall** ≡ Structure built along the coast of the open ocean for erosion control.

**secondary source** ≡ Contaminated origin that may re-release contaminants / threats to the environment.

**sediment** ≡ Small particles of rock debris or organic materials deposited by wind, water, or ice.

**semidiurnal tide** ≡ A tide with two high waters and two low waters each tidal day.

**settlement / settling** ≡ Life history stage of organisms coming out of the water column to the benthos; larval to juvenile.

**silviculture** ≡ The care and cultivation of forest trees; forestry.

**smolt** ≡ A silvery-colored, juvenile Atlantic salmon during its active migration to sea in the spring. Smolts, unlike parr, are able to survive the natural transition from fresh to salt water.

**stock** ≡ A reproductively isolated population of organisms; unit of independent exploitation.
stratified random sampling ≡ Collection regime approach to limit statistical bias.

submerged aquatic vegetation ≡ Rooted, vascular, flowering plants, that, except for some flowering structures, live and grow below the water surface.

substrate ≡ Material making up the base on which an organism lives or to which it is attached.

survivorship ≡ To remain alive or in existence.

suspended particle ≡ Sediment or organic matter within the water column.

synergistic impact ≡ Complex magnification to produce a greater impact than additive effects.

tectonic ≡ The movement of the earth’s crust.

terrestrial ≡ Upland or inland description of the environment.

thermal shock ≡ Drastic change in ambient temperature, causing development or survival considerations.

thermocline ≡ The water layer in which temperature changes most rapidly with increasing depth.

topography ≡ Vertical structure of aquatic, marine or terrestrial terrain.

trophic web ≡ see food web.

turbidity ≡ Reduced visibility in water due to the presence of suspended particles.

variance ≡ The square of the sum divided by the sample size (n); variability in a sample.

well cutting ≡ Byproduct of mining operations.

zooplankton ≡ Planktonic animals.
11.0 REFERENCES


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12.0 ENVIRONMENTAL ASSESSMENT

12.1 PURPOSE AND NEED FOR THE ACTION

The purpose and need for this amendment are discussed in Section 2.2 of the EFH amendment document.

12.2 DESCRIPTION OF THE PROPOSED AND ALTERNATIVE ACTIONS

12.2.1 Guidance from the Interim Final Rule

The guidance from the Interim Final Rule regarding the description and identification of EFH is summarized in Section 3.2 of the EFH amendment document.

12.2.2 Specification of EFH Information Levels for New England FMP Species

The explanation and specification of information levels to be used for designating EFH in the New England region for Council-managed species is provided in Section 3.2 of the EFH amendment document.

12.2.3 Description and Identification of EFH

The methodology used to develop the alternatives considered by the Council for the EFH designations is explained in Section 3.2 of the EFH amendment document. The maps that represent the Council's preferred alternatives, the EFH designation maps, are provided in Section 3.4 of the EFH amendment document.

The following maps represent the suite of alternatives considered by the Council in developing its EFH designations for each of the eighteen Council-managed species. For each life history stage where information existed to develop a set of alternatives, there is a single map for each of the 50%, 75%, 90%, and 100% alternatives. These four maps represent the range of alternatives considered by the Council and presented to the public for review. In some cases, there was not enough information available to develop a distinct set of alternatives for each life history stage of the species (e.g., monkfish eggs are not collected by the NMFS MARMAP survey, so there were no data on the distribution of monkfish eggs from which to develop the standard set of alternatives). The Council used a proxy (e.g., the distribution of adults) and based its EFH designation on the set of alternatives available for the proxy life history stage (i.e., the combination of the distributions of monkfish adults and larvae were used as a proxy for the distribution of monkfish eggs). In these cases, there are no alternatives maps for the life history stage for which there was no information. The EFH designation explains what information was available, and this section includes the alternatives maps for the life history stages used as a proxy.
EFH Designation Alternatives
Atlantic cod (*Gadus morhua*) Eggs

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of Atlantic cod eggs.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of Atlantic cod eggs.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of Atlantic cod eggs.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of Atlantic cod eggs.
EFH Designation Alternatives
Atlantic cod (*Gadus morhua*) Larvae

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of Atlantic cod larvae.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of Atlantic cod larvae.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of Atlantic cod larvae.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of Atlantic cod larvae.
EFH Designation Alternatives
Atlantic cod (*Gadus morhua*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 19% of the observed range of Atlantic cod juveniles.

EFH alternative 2 (75%): This EFH alternative represents 38% of the observed range of Atlantic cod juveniles.

EFH alternative 3 (90%): This EFH alternative represents 60% of the observed range of Atlantic cod juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of Atlantic cod juveniles.
EFH Designation Alternatives
Atlantic cod (*Gadus morhua*) Adults

EFH alternative 1 (50%): This EFH alternative represents 22% of the observed range of Atlantic cod adults.

EFH alternative 2 (75%): This EFH alternative represents 41% of the observed range of Atlantic cod adults.

EFH alternative 3 (90%): This EFH alternative represents 59% of the observed range of Atlantic cod adults.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of Atlantic cod adults.
EFH Designation Alternatives
Haddock (*Melanogrammus aeglefinus*) Eggs

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of haddock eggs.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of haddock eggs.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of haddock eggs.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of haddock eggs.
EFH Designation Alternatives
Haddock (*Melanogrammus aeglefinus*) Larvae

**EFH alternative 1 (50%)**: This EFH alternative represents 50% of the observed range of haddock larvae.

**EFH alternative 2 (75%)**: This EFH alternative represents 75% of the observed range of haddock larvae.

**EFH alternative 3 (90%)**: This EFH alternative represents 90% of the observed range of haddock larvae.

**EFH alternative 4 (100%)**: This EFH alternative represents 100% of the observed range of haddock larvae.
EFH Designation Alternatives
Haddock (*Melanogrammus aeglefinus*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 14% of the observed range of haddock juveniles.

EFH alternative 2 (75%): This EFH alternative represents 32% of the observed range of haddock juveniles.

EFH alternative 3 (90%): This EFH alternative represents 54% of the observed range of haddock juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of haddock juveniles.
EFH Designation Alternatives
Haddock (*Melanogrammus aeglefinus*) Adults

EFH alternative 1 (50%): This EFH alternative represents 19% of the observed range of haddock adults.

EFH alternative 2 (75%): This EFH alternative represents 39% of the observed range of haddock adults.

EFH alternative 3 (90%): This EFH alternative represents 61% of the observed range of haddock adults.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of haddock adults.
EFH Designation Alternatives
Atlantic herring \textit{(Clupea harengus)} Larvae

EFH alternative 1 (50%): This EFH alternative represents 50\% of the observed range of herring larvae.

EFH alternative 2 (75%): This EFH alternative represents 75\% of the observed range of herring larvae.

EFH alternative 3 (90%): This EFH alternative represents 90\% of the observed range of herring larvae.

EFH alternative 4 (100%): This EFH alternative represents 100\% of the observed range of herring larvae.
EFH Designation Alternatives
Atlantic herring (*Clupea harengus*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of herring juveniles.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of herring juveniles.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of herring juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of herring juveniles.
**EFH Designation Alternatives**

*Atlantic herring (Clupea harengus) Adults*

**EFH alternative 1 (50%):** This EFH alternative represents 50% of the observed range of Atlantic herring adults.

**EFH alternative 2 (75%):** This EFH alternative represents 75% of the observed range of Atlantic herring adults.

**EFH alternative 3 (90%):** This EFH alternative represents 90% of the observed range of Atlantic herring adults.

**EFH alternative 4 (100%):** This EFH alternative represents 100% of the observed range of Atlantic herring adults.
EFH Designation Alternatives
Monkfish (*Lophius americanus*) Larvae

- **EFH alternative 1 (50%)**: This EFH alternative represents 50% of the observed range of monkfish larvae.
- **EFH alternative 2 (75%)**: This EFH alternative represents 75% of the observed range of monkfish larvae.
- **EFH alternative 3 (90%)**: This EFH alternative represents 90% of the observed range of monkfish larvae.
- **EFH alternative 4 (100%)**: This EFH alternative represents 100% of the observed range of monkfish larvae.
EFH Designation Alternatives
Monkfish (*Lophius americanus*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 20% of the observed range of monkfish juveniles.

EFH alternative 2 (75%): This EFH alternative represents 41% of the observed range of monkfish juveniles.

EFH alternative 3 (90%): This EFH alternative represents 63% of the observed range of monkfish juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of monkfish juveniles.
EFH Designation Alternatives
Monkfish (*Lophius americanus*) Adults

EFH alternative 1 (50%): This EFH alternative represents 22% of the observed range of monkfish adults.

EFH alternative 2 (75%): This EFH alternative represents 42% of the observed range of monkfish adults.

EFH alternative 3 (90%): This EFH alternative represents 63% of the observed range of monkfish adults.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of monkfish adults.
EFH Designation Alternatives
Ocean pout \((Macrozoarces americanus)\) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 17% of the observed range of ocean pout juveniles.

EFH alternative 2 (75%): This EFH alternative represents 38% of the observed range of ocean pout juveniles.

EFH alternative 3 (90%): This EFH alternative represents 62% of the observed range of ocean pout juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of ocean pout juveniles.
EFH Designation Alternatives
Ocean pout (*Macrozoarces americanus*) Adults

**EFH alternative 1 (50%):** This EFH alternative represents 19% of the observed range of ocean pout adults.

**EFH alternative 2 (75%):** This EFH alternative represents 39% of the observed range of ocean pout adults.

**EFH alternative 3 (90%):** This EFH alternative represents 61% of the observed range of ocean pout adults.

**EFH alternative 4 (100%):** This EFH alternative represents 100% of the observed range of ocean pout adults.
EFH Designation Alternatives
American plaice (*Hippoglossoides platessoides*) Eggs

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of American plaice eggs.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of American plaice eggs.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of American plaice eggs.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of American plaice eggs.
EFH Designation Alternatives
American plaice (*Hippoglossoides platessoides*) Larvae

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of American plaice larvae.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of American plaice larvae.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of American plaice larvae.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of American plaice larvae.
EFH Designation Alternatives
American plaice (*Hippoglossoides platessoides*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 17% of the observed range of American plaice juveniles.

EFH alternative 2 (75%): This EFH alternative represents 32% of the observed range of American plaice juveniles.

EFH alternative 3 (90%): This EFH alternative represents 50% of the observed range of American plaice juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of American plaice juveniles.
EFH Designation Alternatives
American plaice (*Hippoglossoides platessoides*) Adults

EFH alternative 1 (50%): This EFH alternative represents 21% of the observed range of American plaice adults.

EFH alternative 2 (75%): This EFH alternative represents 36% of the observed range of American plaice adults.

EFH alternative 3 (90%): This EFH alternative represents 53% of the observed range of American plaice adults.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of American plaice adults.
EFH Designation Alternatives
Pollock (*Pollachius virens*) Eggs

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of pollock eggs.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of pollock eggs.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of pollock eggs.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of pollock eggs.
EFH Designation Alternatives
Pollock (*Pollachius virens*) Larvae

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of pollock larvae.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of pollock larvae.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of pollock larvae.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of pollock larvae.
EFH Designation Alternatives

Pollock (*Pollachius virens*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 20% of the observed range of pollock juveniles.

EFH alternative 2 (75%): This EFH alternative represents 40% of the observed range of pollock juveniles.

EFH alternative 3 (90%): This EFH alternative represents 62% of the observed range of pollock juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of pollock juveniles.
EFH Designation Alternatives
Pollock (*Pollachius virens*) Adults

- **EFH alternative 1 (50%)**: This EFH alternative represents 21% of the observed range of pollock adults.
- **EFH alternative 2 (75%)**: This EFH alternative represents 40% of the observed range of pollock adults.
- **EFH alternative 3 (90%)**: This EFH alternative represents 61% of the observed range of pollock adults.
- **EFH alternative 4 (100%)**: This EFH alternative represents 100% of the observed range of pollock adults.
EFH Designation Alternatives
Red hake (*Urophycis chuss*) Eggs

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of red hake eggs.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of red hake eggs.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of red hake eggs.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of red hake eggs.
EFH Designation Alternatives
Red hake (*Urophycis chuss*) Larvae

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of red hake larvae.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of red hake larvae.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of red hake larvae.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of red hake larvae.
EFH Designation Alternatives
Red hake (*Urophycis chuss*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 24% of the observed range of red hake juveniles.

EFH alternative 2 (75%): This EFH alternative represents 46% of the observed range of red hake juveniles.

EFH alternative 3 (90%): This EFH alternative represents 67% of the observed range of red hake juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of red hake juveniles.
EFH Designation Alternatives
Red hake (*Urophycis chuss*) Adults

EFH alternative 1 (50%): This EFH alternative represents 21% of the observed range of red hake adults.

EFH alternative 2 (75%): This EFH alternative represents 39% of the observed range of red hake adults.

EFH alternative 3 (90%): This EFH alternative represents 58% of the observed range of red hake adults.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of red hake adults.
EFH Designation Alternatives
Redfish (*Sebastes spp.*) Larvae

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of redfish larvae.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of redfish larvae.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of redfish larvae.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of redfish larvae.
EFH Designation Alternatives
Redfish (*Sebastes* spp.) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 21% of the observed range of redfish juveniles.

EFH alternative 2 (75%): This EFH alternative represents 40% of the observed range of redfish juveniles.

EFH alternative 3 (90%): This EFH alternative represents 61% of the observed range of redfish juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of redfish juveniles.
EFH Designation Alternatives
Redfish (*Sebastes* spp.) Adults

**EFH alternative 1 (50%)**: This EFH alternative represents 23% of the observed range of redfish adults.

**EFH alternative 2 (75%)**: This EFH alternative represents 42% of the observed range of redfish adults.

**EFH alternative 3 (90%)**: This EFH alternative represents 59% of the observed range of redfish adults.

**EFH alternative 4 (100%)**: This EFH alternative represents 100% of the observed range of redfish adults.
EFH Designation Alternatives

Atlantic salmon (*Salmo salar*) All life stages

EFH alternative 1 (Unique): This EFH alternative represents those seven rivers supporting unique stocks of Atlantic salmon that are included in a distinct population segment (DPS).

EFH alternative 2 (Candidate): This EFH alternative represents the seven rivers from the previous alternative plus four rivers currently being considered for possible inclusion in a DPS.

EFH alternative 3 (Restoration): This EFH alternative represents the eleven rivers from the previous alternatives and those with active Atlantic salmon restoration programs [21 rivers].

EFH alternative 4 (Present): This EFH alternative represents all rivers where Atlantic salmon are currently present [26 rivers].
EFH Designation Alternatives
Atlantic salmon (Salmo salar) All life stages

EFH alternative 5 (All): This EFH alternative represents all rivers that have supported Atlantic salmon, including those from which Atlantic salmon have been extirpated [43 rivers].
EFH Designation Alternatives
Atlantic sea scallops (*Placopecten magellanicus*) All life stages

**EFH alternative 1 (50%)**: This EFH alternative represents 30% of the observed range of sea scallops.

**EFH alternative 2 (75%)**: This EFH alternative represents 52% of the observed range of sea scallops.

**EFH alternative 3 (90%)**: This EFH alternative represents 70% of the observed range of sea scallops.

**EFH alternative 4 (100%)**: This EFH alternative represents 100% of the observed range of sea scallops.
EFH Designation Alternatives
White hake (*Urophycis tenuis*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 19% of the observed range of white hake juveniles.

EFH alternative 2 (75%): This EFH alternative represents 39% of the observed range of white hake juveniles.

EFH alternative 3 (90%): This EFH alternative represents 60% of the observed range of white hake juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of white hake juveniles.
EFH Designation Alternatives
White hake (*Urophycis tenuis*) Adults

EFH alternative 1 (50%): This EFH alternative represents 20% of the observed range of white hake adults.

EFH alternative 2 (75%): This EFH alternative represents 36% of the observed range of white hake adults.

EFH alternative 3 (90%): This EFH alternative represents 53% of the observed range of white hake adults.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of white hake adults.
EFH Designation Alternatives
Whiting (*Merluccius bilinearis*) Eggs

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of whiting eggs.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of whiting eggs.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of whiting eggs.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of whiting eggs.
EFH Designation Alternatives
Whiting (*Merluccius bilinearis*) Larvae

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of whiting larvae.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of whiting larvae.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of whiting larvae.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of whiting larvae.
EFH Designation Alternatives
Whiting (*Merluccius bilinearis*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 26% of the observed range of whiting juveniles.

EFH alternative 2 (75%): This EFH alternative represents 48% of the observed range of whiting juveniles.

EFH alternative 3 (90%): This EFH alternative represents 69% of the observed range of whiting juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of whiting juveniles.
**EFH Designation Alternatives**

*Whiting (Merluccius bilinearis) Adults*

<table>
<thead>
<tr>
<th>EFH alternative</th>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (50%)</td>
<td>26%</td>
<td>This EFH alternative represents 26% of the observed range of whiting adults.</td>
</tr>
<tr>
<td>2 (75%)</td>
<td>45%</td>
<td>This EFH alternative represents 45% of the observed range of whiting adults.</td>
</tr>
<tr>
<td>3 (90%)</td>
<td>63%</td>
<td>This EFH alternative represents 63% of the observed range of whiting adults.</td>
</tr>
<tr>
<td>4 (100%)</td>
<td>100%</td>
<td>This EFH alternative represents 100% of the observed range of whiting adults.</td>
</tr>
</tbody>
</table>
EFH Designation Alternatives
Windowpane flounder (*Scophthalmus aquosus*) Eggs

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of windowpane flounder eggs.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of windowpane flounder eggs.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of windowpane flounder eggs.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of windowpane flounder eggs.
**EFH Designation Alternatives**

**Windowpane flounder (*Scophthalmus aquosus*) Larvae**

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of windowpane flounder larvae.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of windowpane flounder larvae.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of windowpane flounder larvae.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of windowpane flounder larvae.
EFH Designation Alternatives
Windowpane flounder (*Scophthalmus aquosus*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 23% of the observed range of windowpane flounder juveniles.

EFH alternative 2 (75%): This EFH alternative represents 41% of the observed range of windowpane flounder juveniles.

EFH alternative 3 (90%): This EFH alternative represents 60% of the observed range of windowpane flounder juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of windowpane flounder juveniles.
EFH Designation Alternatives
Windowpane flounder (Scophthalmus aquosus) Adults

EFH alternative 1 (50%): This EFH alternative represents 24% of the observed range of windowpane flounder adults.

EFH alternative 2 (75%): This EFH alternative represents 42% of the observed range of windowpane flounder adults.

EFH alternative 3 (90%): This EFH alternative represents 60% of the observed range of windowpane flounder adults.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of windowpane flounder adults.
EFH Designation Alternatives
Winter flounder (*Pleuronectes americanus*) Eggs

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of winter flounder eggs.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of winter flounder eggs.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of winter flounder eggs.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of winter flounder eggs.
EFH Designation Alternatives

Winter flounder (*Pleuronectes americanus*) Larvae

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of winter flounder larvae.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of winter flounder larvae.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of winter flounder larvae.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of winter flounder larvae.
EFH Designation Alternatives

Winter flounder (*Pleuronectes americanus*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 17% of the observed range of winter flounder juveniles.

EFH alternative 2 (75%): This EFH alternative represents 34% of the observed range of winter flounder juveniles.

EFH alternative 3 (90%): This EFH alternative represents 54% of the observed range of winter flounder juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of winter flounder juveniles.
EFH Designation Alternatives
Winter flounder (*Pleuronectes americanus*) Adults

**EFH alternative 1 (50%):** This EFH alternative represents 19% of the observed range of winter flounder adults.

**EFH alternative 2 (75%):** This EFH alternative represents 36% of the observed range of winter flounder adults.

**EFH alternative 3 (90%):** This EFH alternative represents 54% of the observed range of winter flounder adults.

**EFH alternative 4 (100%):** This EFH alternative represents 100% of the observed range of winter flounder adults.
EFH Designation Alternatives

Witch flounder (*Glyptocephalus cynoglossus*) Eggs

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of witch flounder eggs.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of witch flounder eggs.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of witch flounder eggs.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of witch flounder eggs.
EFH Designation Alternatives
Witch flounder (*Glyptocephalus cynoglossus*) Larvae

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of witch flounder larvae.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of witch flounder larvae.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of witch flounder larvae.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of witch flounder larvae.
EFH Designation Alternatives
Witch flounder (*Glyptocephalus cynoglossus*) Juveniles

**EFH Alternative 1 (50%)**: This EFH alternative represents 16% of the observed range of witch flounder juveniles.

**EFH Alternative 2 (75%)**: This EFH alternative represents 34% of the observed range of witch flounder juveniles.

**EFH Alternative 3 (90%)**: This EFH alternative represents 58% of the observed range of witch flounder juveniles.

**EFH Alternative 4 (100%)**: This EFH alternative represents 100% of the observed range of witch flounder juveniles.
EFH Designation Alternatives
Witch flounder (*Glyptocephalus cynoglossus*) Adults

EFH alternative 1 (50%): This EFH alternative represents 16% of the observed range of witch flounder adults.

EFH alternative 2 (75%): This EFH alternative represents 33% of the observed range of witch flounder adults.

EFH alternative 3 (90%): This EFH alternative represents 51% of the observed range of witch flounder adults.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of witch flounder adults.
EFH Designation Alternatives
Yellowtail flounder (*Pleuronectes ferruginea*) Eggs

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of yellowtail flounder eggs.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of yellowtail flounder eggs.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of yellowtail flounder eggs.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of yellowtail flounder eggs.
EFH Designation Alternatives
Yellowtail flounder (*Pleuronectes ferruginea*) Larvae

EFH alternative 1 (50%): This EFH alternative represents 50% of the observed range of yellowtail flounder larvae.

EFH alternative 2 (75%): This EFH alternative represents 75% of the observed range of yellowtail flounder larvae.

EFH alternative 3 (90%): This EFH alternative represents 90% of the observed range of yellowtail flounder larvae.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of yellowtail flounder larvae.
EFH Designation Alternatives
Yellowtail flounder (*Pleuronectes ferruginea*) Juveniles

EFH alternative 1 (50%): This EFH alternative represents 19% of the observed range of yellowtail flounder juveniles.

EFH alternative 2 (75%): This EFH alternative represents 37% of the observed range of yellowtail flounder juveniles.

EFH alternative 3 (90%): This EFH alternative represents 56% of the observed range of yellowtail flounder juveniles.

EFH alternative 4 (100%): This EFH alternative represents 100% of the observed range of yellowtail flounder juveniles.
EFH Designation Alternatives

Yellowtail flounder (*Pleuronectes ferruginea*) Adults

**EFH alternative 1 (50%):** This EFH alternative represents 22% of the observed range of yellowtail flounder adults.

**EFH alternative 2 (75%):** This EFH alternative represents 38% of the observed range of yellowtail flounder adults.

**EFH alternative 3 (90%):** This EFH alternative represents 57% of the observed range of yellowtail flounder adults.

**EFH alternative 4 (100%):** This EFH alternative represents 100% of the observed range of yellowtail flounder adults.
EFH Designation Alternatives
Atlantic halibut (*Hippoglossus hippoglossus*) All life stages

**EFH alternative 1 (50%)**: This EFH alternative represents 15% of the observed range of Atlantic halibut.

**EFH alternative 2 (75%)**: This EFH alternative represents 35% of the observed range of Atlantic halibut.

**EFH alternative 3 (90%)**: This EFH alternative represents 60% of the observed range of Atlantic halibut.

**EFH alternative 4 (100%)**: This EFH alternative represents 100% of the observed range of Atlantic halibut.
12.2.4 Information on Proposed Management Measures

The new management action associated with this amendment to the Council's FMPs designates the EFH and HAPC for all Council-managed species. The proposed management measure directed at protecting the juvenile Atlantic cod HAPC is limited to maintaining the current restrictions that already exist within that area, so this measure does not impose any new management action or restrictions.

An overview of existing and proposed management measures that provide habitat conservation benefit to the areas designated EFH by the Council is provided in Sections 4.10 and 4.11 of the EFH amendment document.

12.2.5 Other Options Considered

A discussion of the alternatives considered by the Council, including the status quo alternative, is included in Section 3.2.3 of the EFH amendment document. Maps of the non-preferred alternatives are provided in Section 12.3.3 of this document.

To protect the juvenile Atlantic cod HAPC from the most significant potential adverse impacts from fishing-related activities, the Council considered the following range of alternative measures:

- maintain the current Closed Area II restrictions, pursuant to the provisions of 50 CFR 648.81(b.), for the designated habitat area of particular concern for habitat protection reasons; or,
- close this area to all types of fishing.

The Council considered the range of options in light of the considerations summarized in Section 3.3.1 of the EFH amendment document and, after reviewing public comments and suggestions, determined that maintaining the current closure restrictions is the most appropriate measure to ensure adequate protection of this area. The area is most vulnerable to bottom-tending mobile fishing gear, and these gear types are currently prohibited in the area, as are any other gear types with the potential to catch groundfish. Extending the closure restrictions to preclude all fishing activity would not be warranted, as gear types such as midwater trawls, pelagic gillnets, and pelagic longlines have negligible, if any impact on benthic habitats. The only gear type considered to have the potential to impact benthic habitat is the lobster pot, and lobster pots, at least in moderate numbers, are believed to have minimal impact on the bottom.

12.3 ENVIRONMENTAL IMPACTS OF THE ALTERNATIVES

An environmental assessment (EA) is required by the National Environmental Policy Act of 1969 (NEPA) to determine whether the action considered will result in significant impact on the human environment. If the action is determined not to be significant based on an analysis of relevant considerations, the EA and resulting finding of no significant impact (FONSI) would be the final environmental documents required by NEPA. An
environmental impact statement (EIS) must be prepared for major federal actions significantly affecting the human environment.

An EA must include a brief discussion of the need for the proposal, the alternatives considered, the environmental impacts of the proposed action and the alternatives, and a list of document preparers. The purpose of the proposal is discussed in Section 2.2 of the EFH amendment document, the alternatives are provided in Section 12.3.3 and the list of preparers are provided in Section 12.8 of this document. This section contains the discussion of the environmental impacts of the alternatives including impacts on threatened and endangered species and marine mammals.

12.3.1 Environmental Impacts of the Alternatives to Designate EFH

The environmental impacts generally associated with fishery management actions are effects resulting from (1) harvest of fish stocks which may result in changes in food availability to predators and scavengers, changes in the population structure of target fish stocks, and changes in the marine ecosystem community structure; (2) changes in the physical and biological structure of the marine environment as a result of fishing practices, e.g., effects of gear use and fish processing discards; and, (3) entanglement / entrapment of non-target organisms in active or inactive fishing gear.

Physical Environment

Because of the large variability in the fish species managed under the Magnuson-Stevens Act, the areas identified as EFH will encompass a wide range of aquatic habitats. For example, streams and rivers supporting Atlantic salmon, marine and estuarine habitats, such as seagrass beds, coastal wetlands, submerged aquatic vegetation, cobble with attached epifauna, mud and clay burrows, and oceanic banks and continental shelf or slope areas extending to the 200-mile EEZ, all have the potential to be designated as EFH for one or more fishery species. Geographically, EFH is being designated in all states with a marine coastline. Overall, the environment directly affected by the plan amendment is likely to be primarily marine and estuarine habitat, except for Atlantic salmon where most of the EFH is in freshwater streams and rivers in coastal states.

The affected environment will be a subset of the habitat currently or historically used by fish managed under the Magnuson-Stevens Act. Marine, estuarine, and freshwater environments in coastal states are most likely to be affected. Fish populations managed under the Magnuson-Stevens Act will be affected when EFH receives increased protection or is restored.

In the case of riverine habitat, which is particularly important to Atlantic salmon, habitat loss has resulted from loss of fish access, water pollution, inadequate flow, and physical destruction of habitat. Activities determined to have an adverse impact on EFH may be redirected or concentrated in other areas such as uplands or aquatic areas not identified as EFH.
**Effects on Fish Habitat**

The goal of the EFH amendment is to improve the conservation and management of EFH by providing information and conservation recommendations to federal and state agencies and other entities whose actions may adversely affect EFH. The achievement of this goal depends on individual decisions made by the Council and federal and state agencies. Therefore, the consequences of this proposal can only be addressed in a general sense. NEPA documentation prepared for individual proposed actions by other than the Council will fully address the environmental consequences of site specific activities. Council-proposed actions, taking the form of framework adjustments or future FMP amendments, will address the specific impacts of the proposed actions.

The EFH designation alternatives selected by the Council include the most appropriate amount of habitat area, given the particular conditions of each species and the limitations associated with the data and information available to the Council. Selecting more area to be included in the EFH designations could be considered as risk-averse, or precautionary, but would trigger more consultations than the Council deems necessary. Selecting less area to be included in the EFH designations would trigger fewer consultations and place less burden on federal agencies to comply with the Magnuson-Stevens Act, but would not provide the prudent amount of habitat protection given the level of information available. The only foreseeable impacts to fish habitat from the implementation of the Council’s EFH designations and the conservation and enhancement recommendations provided in the amendment would be improved protection, restoring both the quantity and quality of the region’s most valuable habitats.

**Effects on Fish Populations**

The EFH requirements were included in the Magnuson-Stevens Act because scientific evidence indicated that habitat loss or degradation has compounded, and in some cases magnified, the effects of increased fishing pressures. Protection from further adverse impacts and the restoration of degraded EFH, where feasible, should reduce some of the stress on populations, and fishery stocks should stabilize or regain some lost productivity. Evidence from boreal, temperate, and tropical regions of the world support the theory that if habitat degradation is halted or minimized, and biological integrity is restored, associated fish populations will increase. Additional benefits that would be expected from adequate levels of habitat protection include: the restoration of the population age (or size) structure, conservation of genetic diversity in the population, development or maintenance of greater diversity in trophic structure and greater assurance of the availability of alternate trophic pathways, increased resilience or the population to withstand both natural and anthropogenic stresses, and greater stability in both the populations and the fishery catch. All of the options and alternatives to the status quo considered by the Council would be expected to reduce some of the stress on populations, and fishery stocks should benefit in terms of long-term productivity.

**Effects on Fisheries**

Detrimental effects of any future EFH-related regulations are expected to be temporary in
nature, with any short-term losses more than balanced out by long term gains in the fishery. The long-term expectation of the Magnuson-Stevens Act’s EFH mandate is that declining trends in fish stocks can be halted or reversed by minimizing adverse impacts to EFH, and by restoring lost habitats or access to habitats, where feasible, along with other management measures. Protecting the quality and quantity of EFH should increase the survival potential of Council-managed fishery species, and increase biological productivity of both the ecosystem and the stocks of managed species dependent on the components of that ecosystem. Increases in stock abundance and fish sizes should result in increased economic return and stabilization of interannual variations in catch, as well as provide increased resistance to episodic disturbance events.

The most likely short-term consequence to the fishing participants, both commercial and recreational, of any future action taken by the Council to minimize the impacts to EFH, would be the relocation of fishing effort, if scientific evidence suggests that particular fishing methods or gear types are adversely affecting the quantity or quality of habitat necessary to one or more life stages of a Council-managed species. Restrictions to minimize these adverse effects could be either seasonal, annual, or long-term. For the duration of the restriction, fishermen who have traditionally used that method or area may need to increase their search or travel distance to find other suitable fishing grounds, or they may need to invest in gears more appropriate for use in the identified EFH. There may be individual fishing participants for whom the net effect of reducing adverse impacts to EFH is negative, either because no relocation of effort is possible or because the cost of acquiring new gear is prohibitive, which could cause the participant to withdraw from the fishery. Overall, short-term economic losses should be compensated by future increases in catch levels and increased stability in the fishery.

None of the provisions in the current EFH amendment are expected to incur any cost to the fishing industry. The restrictions on fishing in the area designated as an HAPC for juvenile Atlantic cod have been in place for several years, and no current fishing effort will be restricted from this area. All of the options and alternatives to the status quo are expected to provide long-term gains for New England fisheries.

Other Environmental Effects

The implementation of this amendment should not produce any unavoidable adverse environmental impacts. The provisions of the amendment are intended to protect the environment by controlling adverse physical, biological, and chemical impacts on the habitat of Council-managed fishery species. There may be some changes in the patterns of resource use in order to avoid activities that degrade coastal waters and habitats. These changes, such as directing dredged material disposal away from EFH, would not result in any unavoidable adverse environmental impacts.

The overall purpose of this amendment is to conserve, protect, and restore coastal waters, and thus to enhance the long-term health of Council-managed species. This amendment will not result in any short-term uses of the environment that may reduce long-term productivity. Short-term use of the environment may be modified in response to the implementation of specific EFH conservation recommendations or fishery management...
measures. This may result in short-term costs to the users, but will result in long-term benefits to the economy and environment through the conservation, preservation, and restoration of living marine resources and their habitats.

Consequences of the Alternatives

The consequences of the status quo alternatives for each species would be that EFH would not be designated and a program for the conservation and management of EFH in New England would not be implemented. Federal and state agency decision-makers would not be able to avail themselves of information on the importance of certain habitats to marine fisheries, and their decisions regarding actions that could adversely affect EFH might not give adequate consideration to the need for conservation of particular habitats. Fish populations may remain threatened by habitat loss, and additional fish populations would likely become threatened as habitat loss continued. Commercial and recreational fishermen dependent on declining fisheries would continue to experience lost revenues and increased uncertainty. All of the options and alternatives to the status quo would be expected to benefit Council-managed fishery species populations, and provide for improved long-term productivity of the fisheries.

12.3.2 Environmental Impacts of the Proposed Management Measures

The new mandate to identify, conserve, and enhance EFH is regarded as an important tool for sustainable fisheries and healthy ecosystems. The cobble bottom area in the northern portion of Closed Area II has been designated a habitat area of particular concern due to the value-added benefits to the survival of post-settlement juvenile Atlantic cod derived from the habitat of this area. Maintaining the current closure restrictions in this area will ensure continued protection of this valuable habitat from any potential adverse impacts associated with fishing activity, especially from bottom-tending mobile fishing gear. This closure protects the fragile nature of this important habitat, and prevents the harvest or bycatch of this species during a critical phase of its life history.

12.3.3 Economic Impacts

There are no economic impacts expected to result from the provisions of this amendment.

12.3.4 Social Impacts

There are no social impacts expected to result from the provisions of this amendment.

12.3.5 Impacts on Marine Mammals, Endangered or Threatened Species

A description of potentially affected protected species (marine mammals, sea turtles and shortnose sturgeon), including those that are threatened and endangered or proposed to be listed as threatened or endangered under the Endangered Species Act (ESA), has been provided in Amendments 5 and 7 to the Northeast Multispecies FMP, in Amendment 4 to the Atlantic Sea Scallop FMP, the Atlantic Salmon FMP and the Monkfish and proposed Herring FMPs. The status of these marine mammal populations has been most recently
discussed in the publications entitled *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments*. Initial assessments were presented in Blaylock, *et al.* (1995) and were updated in Waring, *et al.* (1997). The reports present information on stock definition and geographic range, population size and productivity rates, a description of current population trends, an estimate of the annual human-caused mortality and serious injury as well as other causes of stock declines or impediments to recovery, a description of the commercial fisheries that interact with these stocks and an estimate of Potential Biological Removals. The most recent information on sea turtle status is contained in the 1995 and 1997 status reviews of listed turtles prepared jointly by NMFS and the U.S. Fish and Wildlife Service.

Impacts of the existing management measures on endangered and protected species were discussed in the submission documents and in the formal consultations pursuant to Section 7(a)(2) of the ESA, as well as in the associated Biological Opinions issued for the FMP amendments listed above. The EFH Amendment, which contains descriptions of essential fish habitat for all Council-managed species, the identification of fishing threats and associated management measures, in addition to identification of non-fishing threats and the conservation and enhancement measures, does not affect the status quo with regard to fishing activities. Impacts of the measures, therefore, can at least be expected to remain stable. Accordingly, there is no jeopardy to the continued existence of threatened or endangered species.

### 12.4 FINDING OF NO SIGNIFICANT IMPACT

None of the alternatives or provisions of the EFH amendment are likely to significantly affect the quality of the human environment, and the preparation of an environmental impact statement for the proposed action is not required by Section 102(2)(C) of the National Environmental Policy Act or its implementing regulations. Furthermore, maintaining the current Closed Area II restrictions for the juvenile Atlantic cod HAPC is unlikely to significantly affect the quality of the human environment, and the preparation of an environmental impact statement for the proposed action is not required by Section 102(2)(C) of the National Environmental Policy Act or its implementing regulations.

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Assistant Administrator for Fisheries, NOAA              Date
12.5 REFERENCES

The references and literature cited in this document are provided in Section 11.0 of the EFH amendment document.

12.6 LIST OF PREPARERS

12.6.1 Members of the EFH Technical Team

Mr. Michael Pentony, NEFMC Staff, EFH Technical Team Chair
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Dr. Jeremy Collie, University of Rhode Island Graduate School of Oceanography
Dr. Jeff Cross, NMFS NEFSC Howard Marine Sciences Lab
Dr. Joe DeAlteris, University of Rhode Island
Ms. Laura Ernst, Rhode Island Coastal Resources Management Council
Ms. Patricia Fiorelli, NEFMC Staff
Mr. Arnold Howe, Massachusetts Division of Marine Fisheries
Mr. Jon Kurland, NMFS Northeast Regional Office, Habitat Division
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Mr. Joe Pelczarski, Massachusetts Coastal Zone Management Program
Mr. Stephen Rideout, U.S. Fish & Wildlife Service
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12.6.2 Other Contributors

Mr. Peter Auster, National Undersea Research Center
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Mr. Nick Jenkins, Commercial Fisher
Mr. Mark Leach, Cape Cod Commercial Hook Fishermen's Association
Ms. Maggie Mooney-Seus, New England Aquarium
Ms. Maggie Raymond, Associated Fisheries of Maine
Dr. Fred Short, University of New Hampshire, Jackson Estuarine Lab
Mr. Ronald Smolowitz, Gear Specialist
Dr. David Stevenson, Maine Department of Marine Resources
Mr. Ed Baum, Maine Atlantic Salmon Authority
Mr. Mark Monoco, NOAA / NOS / SEA Division
13.0 **APPLICABLE LAW**

13.1 **MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT**

Amendment 9 to the Multispecies FMP, Amendment 7 to the Sea Scallop FMP, the Monkfish FMP, and the forthcoming Atlantic Herring FMP contain the Council's determination of consistency with the National Standards. This amendment does not change the rules promulgated under these FMPs and amendments; therefore, no further consideration is required.

13.2 **NATIONAL ENVIRONMENTAL POLICY ACT**

A finding of no significant impact was determined for this proposed action; see Section 12.6 of this document.

13.3 **REGULATORY IMPACT REVIEW**

This section provides information about the likely economic and socioeconomic impacts of the alternatives including identification of the individuals or groups that may be affected by the action, the nature of these impacts, quantification of the economic impacts if possible, and discussion of the tradeoffs between qualitative and quantitative costs and benefits.

The requirements for all regulatory actions specified in Executive Order 12866 are summarized in the following statement from the order:

> In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity), unless a statute requires another regulatory approach.

This section also addresses the requirements of the E.O. 12866 and the Regulatory Flexibility Act (RFA) to provide adequate information to determine whether an action is "significant" under E.O. 12866 or will result in "significant" impacts on small entities under the RFA.

E.O. 12866 requires that the Office of Management and Budget review proposed regulatory programs that are considered to be "significant". A "significant regulatory
action" is one that is likely to:

1. Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local or tribal government or communities;

2. Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

3. Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of the recipients thereof; or,

4. Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive Order.

A regulatory program is "economically significant" if it is likely to result in the effects described above. The Regulatory Impact Review (RIR) is designed to provide information to determine whether the proposed regulation is likely to be "economically significant."

13.3.1 Economic Impact on Small Entities

The objective of the RFA is to require consideration of the capacity of those affected by regulations to bear the direct and indirect costs of regulation. If an action will have a significant negative impact on a substantial number of small entities, an Initial Regulatory Flexibility Analysis (IRFA) must be prepared to identify the need for the action, alternatives, potential costs and benefits of the action, the distribution of these impacts, and a determination of net benefits.

The Small Business Administration has defined all fish-harvesting or hatchery businesses that are independently owned and operated, not dominant in their field of operation, with annual receipts not in excess of $3,000,000 as small businesses. In addition, seafood processors with 500 employees or fewer, wholesale industry members with 100 employees or fewer, not-for-profit enterprises, and government jurisdictions with a population of 50,000 or less are considered small entities. NMFS has determined that a "substantial number" of small entities would generally be 20% of the total universe of small entities affected by the regulation. A regulation would have a negative "significant impact" on these small entities if it reduced annual gross revenues by more than 5 percent, increased total costs of production by more than 5 percent, or resulted in compliance costs for small entities that are at least 10 percent higher than compliance costs as a percent of sales for large entities.

The proposed EFH designations will have no impact on small entities, fishermen, or fishing businesses, as the designations are not regulatory in nature and are limited to identifying the physical characteristics and geographic extent of the areas of priority interest to the Council and other regulatory agencies. Any regulatory action anticipated
by this plan amendment (maintaining the current Closed Area II closure restrictions within the area designated as an HAPC for juvenile Atlantic cod for habitat conservation reasons) would not be expected to have a significant impact on small entities, fishermen, or fishing businesses, as the proposed restrictions already exist in the area and there will be no additional restrictions on current fishing practices. The area affected by this proposal is extremely small (<0.2%) relative to the total available fishing area in the New England area.

13.3.2 Economic Impact of the Proposed Management Measure to Protect the Juvenile Atlantic Cod Habitat Area of Particular Concern

Maintaining the current Closed Area II closure restrictions in the area designated as a habitat area of particular concern for juvenile Atlantic cod will not cause any economic impacts to fishermen. The HAPC is wholly contained within Closed Area II, and even if the current restrictions were not extended to this area for habitat protection or conservation reasons, the closure restrictions would still exist. There are no additional restrictions or requirements placed on any segment of the fishing industry as a result of this proposed measure.

13.3.3 Summary Finding of Economic Impacts

There are two actions proposed in this plan amendment. The first is simply to describe and identify EFH for all species managed by the Council, which in and of itself, will have no economic impact. The second proposed action in this plan amendment is to establish a habitat area of particular concern for juvenile Atlantic cod and maintain the existing Closed Area II closure restrictions in this area for habitat protection reasons. As discussed in the previous section, this measure is not expected to cause any economic impacts to fishermen. None of the alternatives is expected to result in a "significant regulatory action" as defined in E.O. 12866.

13.4 EXECUTIVE ORDER 12866

The proposed action does not constitute a significant regulatory action under Executive Order 12866; see Section 13.3 of this document.

13.5 REGULATORY FLEXIBILITY ACT

The proposed action will not have a significant economic impact on a substantial number of small entities and a Regulatory Flexibility Analysis is not required; see Section 13.3 of this document.

13.6 MARINE MAMMAL PROTECTION ACT

The New England Fishery Management Council does not believe that this management program will have any adverse effect on marine mammals that occur within the range of species in the management units of the applicable Fishery Management Plans. Commercial fishing operations and vessels which have valid fishing permits issued in
accordance with Section 204(b) of the Magnuson-Stevens Fishery Conservation and Management Act are subject to the provisions of the MMPA and specifically Section 114 which governs the incidental take of marine mammals. See Section 12.5.5 of this document for a discussion of impacts on marine mammal populations.

13.7 ENDANGERED SPECIES ACT

The New England Fishery Management Council does not believe that this management program will have any adverse effect on any threatened or endangered species that occur within the range of species in the management units of the applicable fishery management plans. Commercial fishing operations and vessels which have valid fishing permits issued in accordance with Section 204(b) of the Magnuson-Stevens Fishery Conservation and Management Act are subject to the provisions of the ESA. See Section 12.5.5 of this document for a discussion of impacts on populations of endangered species.

13.8 COASTAL ZONE MANAGEMENT ACT

Implementation of the provisions of this amendment will be conducted in a manner consistent, to the maximum extent possible, with the coastal zone management programs of all states within the geographic extent of the Council's EFH designations, including all coastal states from Maine to North Carolina, within the meaning of Section 307(c)(1) of the Coastal Zone Management Act of 1972 and its implementing regulations. The Council has submitted this amendment package to the coastal zone management programs of all states within the geographic extent of the Council's EFH designations, including all coastal states from Maine to North Carolina, for review. Copies of the transmittal letters that have the Council's determination of whether the proposed measures are consistent with the coastal zone management plans for the individual states are contained in Appendix F.

No state concurrences with the Council's determinations have been received at the time of submittal of the EFH Amendment.

13.9 PAPERWORK REDUCTION ACT (PRA)

Copies of the PRA analyses for Amendment 9 to the Multispecies FMP, Amendment 7 to the Sea Scallop FMP, the Monkfish FMP, and the forthcoming Atlantic Herring FMP are available from the NMFS Regional Office, Gloucester, Massachusetts. This action includes no new collection of information and further analysis is not required.
14.0 PUBLIC COMMENTS SUMMARY AND COUNCIL RESPONSES

The following section contains a summary of written and verbal comments received during the EFH public hearing and review period from July 1 - July 31, 1998. The comments are not presented verbatim since the same point was often made by more than one individual. Further, a number of comments addressed points not directly relevant to the amendment proposals, objectives or analyses. These comments are not included in the summary, although they are provided in Volume III of the amendment package which includes all comments provided to the Council. This section also includes brief responses from the Council related to the comments.

General Comments Related to Essential Fish Habitat:

1. **Comment:** A large number of letters, form letters, and verbal comments supported the Council's essential fish habitat designations. The Council received a few comments that it should add a ten minute square to EFH designation for Atlantic herring eggs.

   **Response:** The Council maintained the EFH designations as presented in the EFH public hearing document, except for Atlantic salmon, Atlantic halibut and Atlantic herring. Additional information was presented by the State of Maine which contradicted the information used to include the Medomac and St. George rivers in the Atlantic salmon EFH designation, so these rivers were removed from the designation. Based on the information received during the public hearing process and on further Council deliberation, EFH was designated for Atlantic halibut based on a combination of the historic range and the current scientifically observed range. The Council considered the additional information presented by the Maine Department of Marine Resource related to the EFH designation for Atlantic herring eggs and determined it most appropriate to include this additional area. All other proposed EFH designations remained the same and are reflected in Section 3.4 of the EFH amendment.

2. **Comment:** A comment expressed concern that the Council should not attempt to designate EFH until all of the sea bottom is mapped.

   **Response:** The Council was obligated, by the Sustainable Fisheries Act, to designate EFH for all managed species, using the best information available and to complete these designations by October 11, 1998. While having detailed maps of the entire sea bottom would allow the Council to refine its designations, adequate information exists to develop initial designations that meet the intention of the law.

3. **Comment:** Several comments reflected concern about the future of EFH and how the Council will implement measures to protect habitat. At least one comment noted that the lack of specific measures to implement EFH is a problem. Several comments also expressed concern that the Council will use the EFH designations to close all of Georges Bank to all fishing activity.
Response: The Council has developed an EFH Strategic Plan (Section 8.0) that outlines how the Council will continue the EFH management process over the next five years, leading up to a review and revision of all the Council's EFH designations. This plan also explains how the Council will pursue the development and implementation of measures determined necessary to protect EFH from any adverse impacts associated with fishing activity. Although all of Georges Bank is designated EFH for one species or another, the Council will use the designations to pinpoint small areas that are EFH for multiple species at especially critical life history stages. If measures are determined necessary to protect EFH from any adverse impacts associated with fishing activity, these small areas would most likely be the focus of Council consideration.

4. Comment: There were several comments that the Council's EFH designations are too broad and encompass too much area.

Response: The Council designated EFH for all species as narrowly or as broadly as was most appropriate for each species, based on the guidelines provided to the Council by NMFS, the information available on each species, and the status of the stocks. In some cases the EFH designation for a particular species is a broad expansive area and this occurred when there was little information on the species or when the species was in a overfished condition. In other cases, in light of detailed information and/or a species that was not overfished, the Council designated EFH more narrowly. The Council will continue to review the EFH designations, and refine them as more information becomes available.

5. Comment: The Council received several comments suggesting that natural events impact bottom habitats more than man-made impacts and therefore the Council should not manage habitat as habitat issues are not a problem.

Response: The Council is required by the Sustainable Fisheries Act to identify and describe the EFH for all managed species and take action to manage both the fishing and non-fishing related activities that have the potential to adversely impact EFH. There is a substantial amount of scientific literature that suggests that both some fishing and non-fishing related activities have the potential and do cause adverse impacts to the habitat of our fishery resources. Sections 4.0, 5.0, and Appendix E describe these activities and the impacts they can cause.

6. Comment: The Council received a comment that there is no indication how the Council will use the EFH designations for habitat conservation and management.

Response: Sections 4.0 and 5.0 provide an assessment of the potential adverse impacts to EFH from fishing and non-fishing related activities. Section 4.0 also describes the Council's existing management measures which provide habitat conservation benefits and the process the Council will use to implement future conservation measures, should they be determined to be necessary. Section 6.0 of the amendment describes the conservation and enhancement measures that the Council recommends to mitigate non-fishing impacts to EFH. Section 8.0 describes the
Council's EFH Strategic Plan for continuing its habitat management program.

7. **Comment:** The Council received a comment that the Council clarify its explanation of the methodology for developing the EFH designations.

**Response:** This has been done in the EFH amendment document, Section 3.2.

8. **Comment:** The Council received one comment that the entire EFH amendment document should be made available for public review rather than a public hearing document.

**Response:** The Council policy is to publish a public hearing document that summarizes the points under consideration by the Council, rather than to develop an FMP document in its entirety prior to receiving public input. Many sections of FMPs and amendments are required by law, but not of highest interest to the public. Public hearing documents are designed to be shortened, summary versions of the Council decision documents in order for the public to understand the most significant decisions before the Council and to provide input on those decisions as efficiently as possible. Waiting to develop the full amendment package, then sending out documents that are often several hundreds of pages would unnecessarily delay and overwhelm the public process.

9. **Comment:** The Council received one comment that the Council should send public hearing notices to all towns in the region.

**Response:** The Council has a mailing list that it maintains of all individuals and organizations that have expressed an interest in being kept abreast of Council issues and made aware of Council meetings and hearings. All individuals and organizations on the Council mailing list are sent notices of public hearings. The Council also sends notices to several newspapers in the New England and Mid-Atlantic region. Council management actions are focused on the fishing industry and the major fishing communities receive hearing notices through their local fishing organizations and commissions. Sending additional notices to all communities in the affected regions (often all New England and Mid-Atlantic coastal states) would be cost prohibitive and unnecessarily redundant.

10. **Comment:** The Council received two comments opposing the designation of Wells Harbor, Maine as EFH, suggesting that the appropriate scientists were not consulted, that there was no information contributing to the designation, and that the designation was intended to prevent a maintenance dredging activity.

**Response:** Wells Harbor, Maine, was designated EFH for five species: Atlantic herring, white hake, windowpane flounder, winter flounder, and yellowtail flounder. The information used to develop these designations was obtained from the NOAA Estuarine Living Marine Resources (ELMR) program reports. A summary of these reports and an explanation of the Council's rationale for incorporating the information they contain in the EFH designation process is provided in Section 3.2.2 of the amendment. Local scientists were consulted in the development of the ELMR reports.
used by the Council. The Council made great efforts to ensure that all EFH
designations were based on biological information without regard to human activities
or their impacts -- addressing impacts to EFH separately. Review of any planned
maintenance dredging operation will fall under the EFH consultation process led by
NMFS. The Council will support NMFS in this process. No EFH designations were
made for the purposes of preventing any specific actions including dredging.

11. **Comment:** There was a single comment asking where the habitat area of particular
concern (HAPC) concept came from.

**Response:** The guidelines published in the *Federal Register* via an Interim Final
Rule on December 19, 1997, Volume 62, Number 244, describes the definition,
criteria and use of HAPCs. §600.810, §600.815(a)(6), §600.815(a)(7), and
§600.815(a)(9) provide detailed guidance to the Council regarding the designation
and management of HAPCs.

12. **Comment:** The Council received a comment that when using adult distributions as a
proxy for designating EFH for eggs and/or larvae, the Council should limit the use of
the proxy to the distribution of spawning adults, rather than the entire range of adults.

**Response:** The Council agrees with the intent of this comment, unfortunately, the
data and information available to the Council did not differentiate between the range
of adults in general and the range of spawning adults. As this information is made
available, the Council will refine its EFH designations.

**Comments Related to the Proposed Juvenile Atlantic Cod HAPC Designations:**

13. **Comment:** A large number of letters, form letters, and verbal comments supported
maintaining current closure restrictions for the juvenile Atlantic cod HAPCs, rather
than restricting the use of all fishing activity within this area. The Council received
several letters of support for providing these areas permanent protection from
destructive fishing practices. The Council received several comments specifically
opposed to closing the juvenile Atlantic cod HAPCs to all types of fishing activity.

**Response:** The Council proposes to maintain the current Closed Area II closure
restrictions for the juvenile Atlantic cod HAPC and, by doing so, the Council did not
propose to close the area to all types of fishing activity. For a discussion of the
Council's rationale for choosing this alternative, see Section 12.2.5. No action that
the Council takes is ever "permanent" as a later Council action can undo the earlier
action.

14. **Comment:** A large number of form letter and other written comments suggested that
there is evidence of areas in Gulf of Maine that should be designated as HAPCs for
juvenile Atlantic cod.

**Response:** The comments did not provide any additional information and the
Council did not have access to any information suggested by these comments. The
Council will pursue this issue and continue to review any information made available.
The Council has the option to designate additional HAPCs using the framework adjustment process.

15. **Comment:** The Council received several comments supporting the designation of two areas (one in Closed Area II and one in Closed Area I) as juvenile Atlantic cod HAPCs.

**Response:** The Council considered the information available on both areas and determined that only the information available for Closed Area II was sufficient for the Council to designate this area as an HAPC. The information on the area within Closed Area I was insufficient to make an HAPC designation.

16. **Comment:** The Council received several comments that the proposed HAPC designation for juvenile Atlantic cod in Area I was based on insufficient and inconclusive information.

**Response:** The Council considered the information available on both areas and determined that only the information available for Closed Area II was sufficient for the Council to designate this area as an HAPC. The information on the area within Closed Area I was insufficient to make an HAPC designation.

17. **Comment:** The Council received several comments opposing the areas proposed for juvenile Atlantic cod HAPCs, either because the information on which the designations were based is wrong (either there is no cobble in these areas or there are no juvenile cod in these areas), because these areas are productive scallop grounds and therefore should not be designated juvenile Atlantic cod HAPCs, or because there may not be enough information to support the cod HAPC designations.

**Response:** There is a substantial literature of scientific studies that demonstrates the importance of this habitat type and the characteristics found in Closed Area II for increased survival of recently settled juvenile Atlantic cod (see Section 3.3.1 for summary). NMFS research clearly indicates an abundance of juvenile Atlantic cod within the HAPC designated in Closed Area II. Independent scientific research has, for several years, documented the location of cobble substrate along the northern edge of Georges Bank. Taken together, this information provides more than enough of a basis for designating the small area on the northern edge of Closed Area II as an HAPC for juvenile Atlantic cod.

18. **Comment:** The Council received one comment that the range of management alternatives presented to conserve the juvenile Atlantic cod HAPC does not really represent the two extremes of possible measures.

**Response:** The Council felt that going out to public hearing with a range of alternatives from maintaining the status quo to the most restrictive possible measure (prohibiting all fishing activity in the area) did represent the two extremes of measures it could implement for this area.

19. **Comment:** The Council received one comment that the juvenile Atlantic cod HAPC
is also an important area for herring (egg beds).

**Response:** The Council recognizes that this may be the case, and the Council will continue to review the information on this area and take additional action, as appropriate.

**Comments on the Proposed Atlantic Salmon EFH and HAPC Designations:**

20. **Comment:** The Council received two comments that it should be more specific in the designation of Atlantic salmon EFH, as well as a comment that the best available data was not used to designate salmon EFH.

**Response:** The Council agrees that with more detailed information it may be able to refine the EFH designations for Atlantic salmon to be more specific and limited to specific portions of rivers, rather than the entire river watershed. At this point, however, the information available to the Council did not provide a level of detail sufficient for the Council to limit the EFH designations beyond naming entire river systems as EFH. It is important to note that the Atlantic salmon EFH Text Description (Section 3.4) does provide limiting factors, such as substrate type, water depth, etc. for the EFH designation.

21. **Comment:** The Council received one comment that the river tributaries should be included in Atlantic salmon EFH designations.

**Response:** In its review of the information available, the Council agreed that the Atlantic salmon EFH designations should include the tributaries to the named river systems. The Atlantic salmon EFH Text Description clearly states that these tributaries are included in the EFH designation.

22. **Comment:** The Council received one comment that the St. Croix River should not be considered EFH for Atlantic salmon because it borders Canada.

**Response:** The Council considered the available information and the methodology used to designate EFH for Atlantic salmon and the St. Croix River met the criteria set by the Council. However, the Council can only designate EFH in U.S. waters, so, by definition, only those portions of the St. Croix River that are within the U.S. border are included in the EFH designation for Atlantic salmon.

23. **Comment:** The Council received a few comments that it should limit the Atlantic salmon HAPC designation to seven rivers in Maine rather than the proposed eleven rivers.

**Response:** The Council considered all available information regarding the appropriateness of designating just the seven rivers, or all eleven rivers as HAPCs for Atlantic salmon. Considering the importance of all eleven rivers for Atlantic salmon, and the likelihood that the salmon from the four rivers in question are part of the same distinct population segment as the salmon from the other seven, the Council felt that it was appropriate to include all eleven rivers in the Atlantic salmon HAPC
designation. These four rivers met the same criteria used by the Council to designate HAPC for Atlantic salmon as the other seven.

24. **Comment:** The Council received one comment that it should designate all eleven proposed rivers as HAPC for Atlantic salmon.

**Response:** The Council considered all available information regarding the appropriateness of designating just the seven rivers, or all eleven rivers as HAPCs for Atlantic salmon. Considering the importance of all eleven rivers for Atlantic salmon, and the likelihood that the salmon from the four rivers in question are part of the same distinct population segment as the salmon from the other seven, the Council felt that it was appropriate to include all eleven rivers in the Atlantic salmon HAPC designation.

25. **Comment:** The Council received one comment that the Connecticut and Merrimack Rivers should be considered for HAPC designation for Atlantic salmon.

**Response:** Based on the information available to the Council in review of this issue, it did not appear that the habitat of these two rivers met the criteria for HAPC designation. The rivers are not thought to support salmon from the distinct population segment of salmon that occupy the rivers in Maine, and thus do not meet the criteria set by the Council. These rivers are considered EFH for Atlantic salmon.

**Comments Related to Fishing Related Impacts Assessment:**

26. **Comment:** The Council received one comment that lobster gear (pots) has no adverse impact on habitat. This individual was concerned that the Council might assume that all gear has the same impact and that to protect EFH, the Council might prohibit all types of fishing gear.

**Response:** While it is possible that under certain conditions and used a certain way, lobster pots would have the potential to adversely impact certain types of benthic habitat, based on the available information, under most conditions lobster pots contribute minimally, if at all, to the adverse impacts on habitat associated with fishing activity. The Council recognizes this and in no case did the Council propose to restrict the use of lobster pots for habitat protection.

27. **Comment:** The Council received several comments that scallop dredging contributes to habitat destruction, and because of this, scallopers should not be allowed in the Closed Areas.

**Response:** The Council agrees that there is evidence that scallop dredges have the potential to cause adverse impacts to certain types of benthic habitats. No where in the EFH amendment does the Council propose to allow scallop dredges into any of the Council's current closed areas where they are currently prohibited.

28. **Comment:** The Council received *two* comments that scallop gear does no more damage to habitat than any other gear, and that scallop dredges actually enhance
Response: All fishing gears interact with the bottom in different ways and have different impacts on different types of habitat. On some types of habitat, certain gears may have a greater potential to cause an adverse impact, while on other types of habitat, different gears may have a greater potential to cause an adverse impact. There may be certain conditions under which a scallop dredge may enhance habitat, but the scientific literature available to the Council largely suggests that scallop dredges are more often associated with adverse impacts to habitat.

29. Comment: The Council received one comment that killing epifauna may not be bad for the environment.

Response: There is no evidence to support this assertion, but if the Council received scientific information which does support the assertion, it would give it due consideration. Emergent epifauna provides a third dimension to the sea floor, providing shelter for many juvenile groundfish to avoid predation, as well as attracting organisms which are prey for these juvenile groundfish.

30. Comment: The Council received many individual letters and form letters suggesting that the Council's EFH management proposal does not go far enough to protect EFH from the adverse impacts associated with fishing activity.

Response: The existing management measures and the new management measures proposed in the Council's SFA amendments provide significant conservation benefit to EFH. The Council will continue to examine any adverse impacts to EFH associated with fishing activity and will implement new management measures if it determines that such action is required to meet the intent of the Sustainable Fisheries Act. Section 8.0 describes the process the Council will use to continue this process.

31. Comment: The Council received one comment that the current management measures do not protect EFH.

Response: The Interim Final Rule suggests three options for managing the adverse effects from fishing: (1) fishing equipment restrictions; (2) time/area closures; and, (3) harvest limits. The Council currently employs all three of these mechanisms in the various fisheries it manages and, as such, these existing measures meet the standard set out in the Interim Final Rule for protecting EFH.

Comments Related to the Non-Fishing Related Impacts Assessment:

32. Comment: The Council received several comments expressing concern about the impacts on habitat of non-fishing related activities.

Response: The Council is also concerned about non-fishing related impacts to EFH and has completed an assessment of the most significant non-fishing related threats to EFH (Section 5.0) and has developed habitat conservation and enhancement recommendations to mitigate these impacts (Section 6.0).
33. **Comment:** The Council received two comments that it should prioritize the most significant non-fishing impacts and develop trigger levels for Council involvement.

**Response:** The Council recognizes that it can not become involved with all decisions relating to non-fishing related activities that may adversely impact EFH, but it does not want to unnecessarily rule out possible involvement in the future, regardless of the level of the activity.

34. **Comment:** The Council received one comment that it should take a stand against land-based outfall systems, especially the Massachusetts Bay outfall pipe system.

**Response:** The Council does intend to keep informed of developments in this area and will review information as it becomes available, especially on the Massachusetts Bay outfall system. If and when appropriate, the Council will become actively involved and provide comments to the relevant agencies.

**Comments on the Proposed Framework Adjustment Process:**

35. **Comment:** The Council received several comments supporting the use of a framework adjustment process to streamline future EFH actions.

**Response:** The Council has proposed to use the framework adjustment process detailed in Section 4.12 of the amendment to streamline future designations of EFH or HAPC and to implement future management measures for the conservation of EFH.

36. **Comment:** The Council received two comments opposing the use of a framework adjustment process to streamline future EFH actions.

**Response:** The Council has proposed to use the framework adjustment process detailed in Section 4.12 of the amendment to streamline future designations of EFH or HAPC and to implement future management measures for the conservation of EFH. The Council's framework adjustment process complies fully with the Administrative Procedures Act which ensures the appropriate level of public input. This is the most efficient mechanism the Council can use to accommodate future action. The public will continue to have an opportunity to provide input on all actions proposed by the Council.