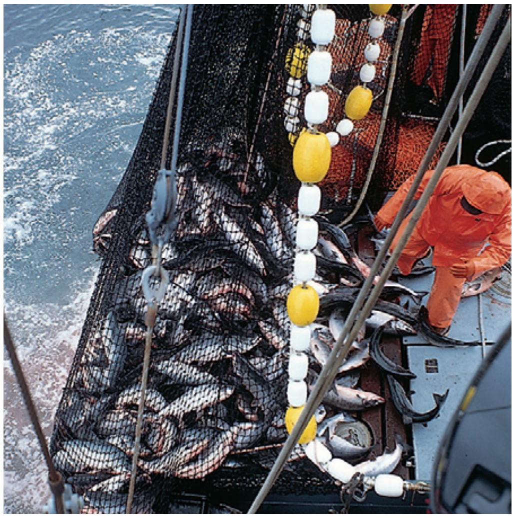
Introduction



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Fishing and fish habitat in the United States. Top left, commercial salmon fishing in Alaska; top right, sport fishing on the Atlantic coast; bottom left, spawning habitat for Alaskan salmon; bottom right, mangrove habitat essential to juvenile fish species in tropical Atlantic coastal waters.

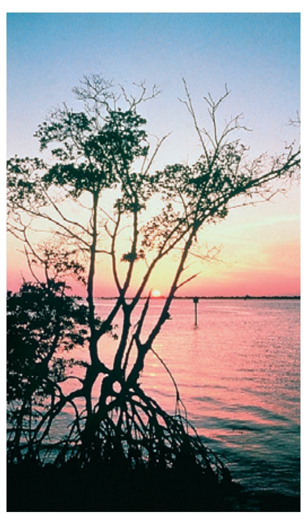
OVERVIEW

Commercial and recreational fisheries contribute billions of dollars annually to the United States economy. In 2012, commercial and recreational marine fisheries generated $199 billion in sales impacts, contributed $89 billion to the U.S. Gross Domestic Product (GDP), and supported 1.7 million jobs in the fishing sectors and across the broader economy (NMFS, 2014a). Until quite recently, most people considered marine fishery resources to be abundant and inexhaustible. Overfishing, natural environmental changes, and habitat loss and degradation, including poor water quality, have put increasing pressures on coastal, anadromous, and oceanic resources. River, lake, "Coastal ecosystems provide many vital ecological and economic services, including shoreline protection, productive commercial and sport fisheries, and nutrient cycling. Key nearshore ecosystems such as seagrass meadows, marshes, and mangrove forests are particularly valued for their extremely high productivity, which supports a great abundance and diversity of fish as well as shrimp, oysters, crabs, and other invertebrates. Because of the abundance of juvenile fish and shellfish they contain, nearshore ecosystems are widely considered 'nurseries.' The nursery role of coastal estuaries and marine ecosystems is well accepted by scientists, conservation organizations, fisheries managers, and the public, and it is often cited to support protection and conservation of these areas. Nonetheless, comparatively little money and effort is being directed at protecting and managing these ecosystems. Until recently, even fisheries managers have largely ignored the issue of identification and conservation of juvenile habitat."

—Excerpt from The Role of Nearshore Ecosystems as Fish and Shellfish Nurseries by Beck et al. (2003).

Photos, left to right: Marsh habitat at the Patuxent River at low tide, and a mangrove tree showing the habitat-enhancing root system of this species.


Mary Hollinger, NODC, NOAA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estuary, coast, and deep ocean habitats provide essential services—such as food, shelter, and space for reproduction and growth—to many species including fish, shellfish, crustaceans, birds, marine mammals, and sea turtles. Habitat damage and loss threaten the sustainability of the Nation's fisheries and the recovery of protected resources. It also makes coastal areas much more vulnerable to hurricanes and coastal storms.

One need not be a scientist to understand that plants and animals are affected by development of coasts, rivers, and lakes. Any trip to the water makes this perfectly clear. What is not clear, however, is how much habitat is needed to sustain fishery yields, the extent to which species depend on these habitats for growth and reproduction, or the status of these habitats in terms of pollution, loss, and fragmentation.

One of the first steps in developing a conservation program is to "take inventory" by determining the quantity and quality of available habitats, the abundance and health of species residing in the habitats, and the extent and severity of habitat loss and degradation. By assessing the situation and providing this information to decisionmakers at all levels of government and to the concerned public, appropriate actions can be formulated and implemented.

In 2009, an initial, abbreviated summary was published on the status and trends of those habitats used by the living marine resources under the purview of NOAA's National Marine Fisheries Service (NMFS). It was entitled *Our Living Oceans: Habitat. Status of the Habitat of U.S. Living Marine Resources. Policymakers' Summary* (NMFS, 2009a). The new report presented herein is the first comprehensive national summary of the status and trends of the habitats used by the living marine resources under the purview of NMFS. It is considerably updated from the 2009 summary report. The document is part of the *Our Living Oceans* series, joining the later versions of *Our Living Oceans* reports on living marine resources (NMFS, 1999b; NMFS, 2009b) and economics (NMFS, 1996). For the first time, there are now comprehensive reviews of the Nation's living marine resources, the habitats they use, and the economic vitality and value of the industries that depend on them.

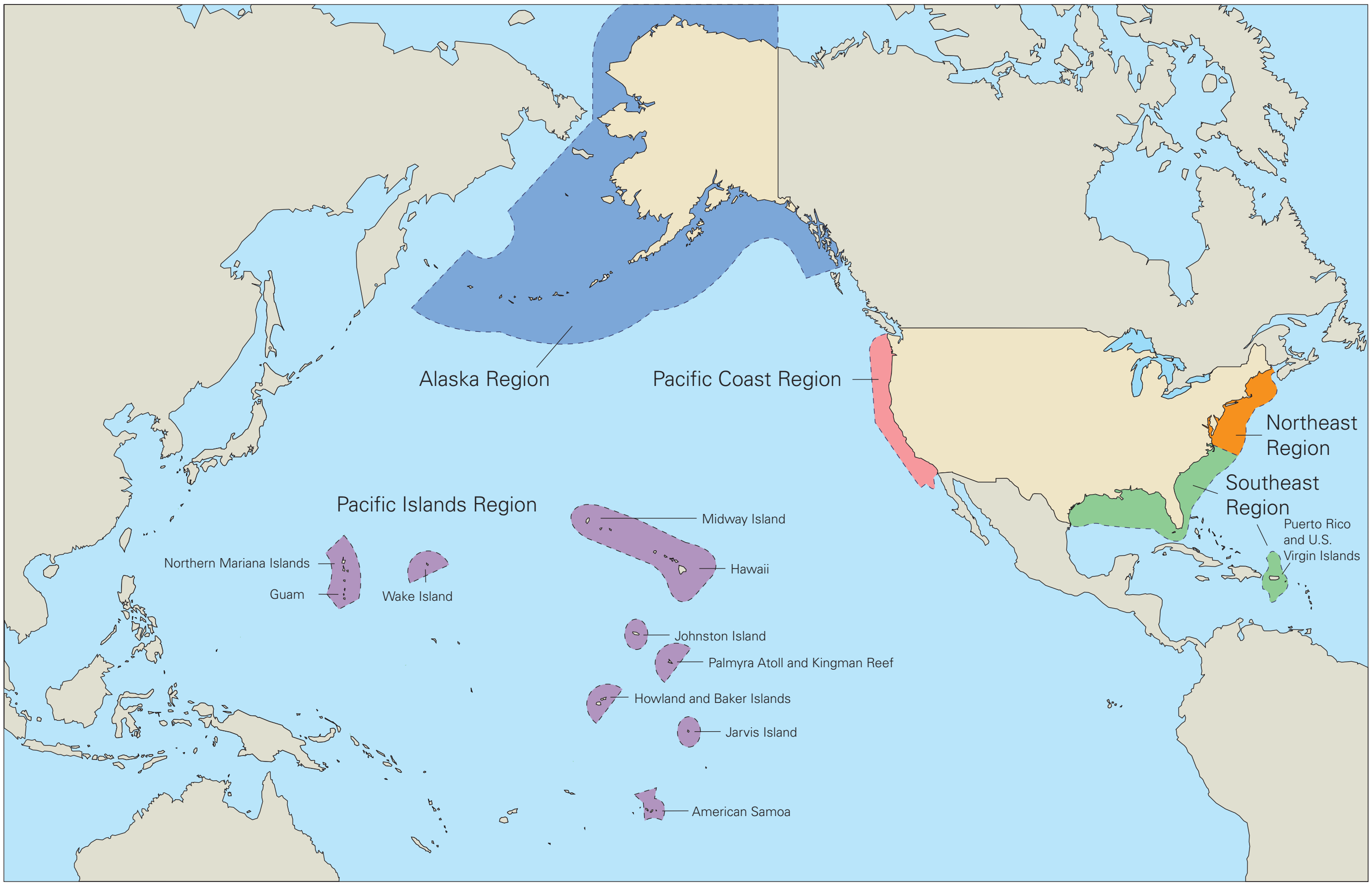


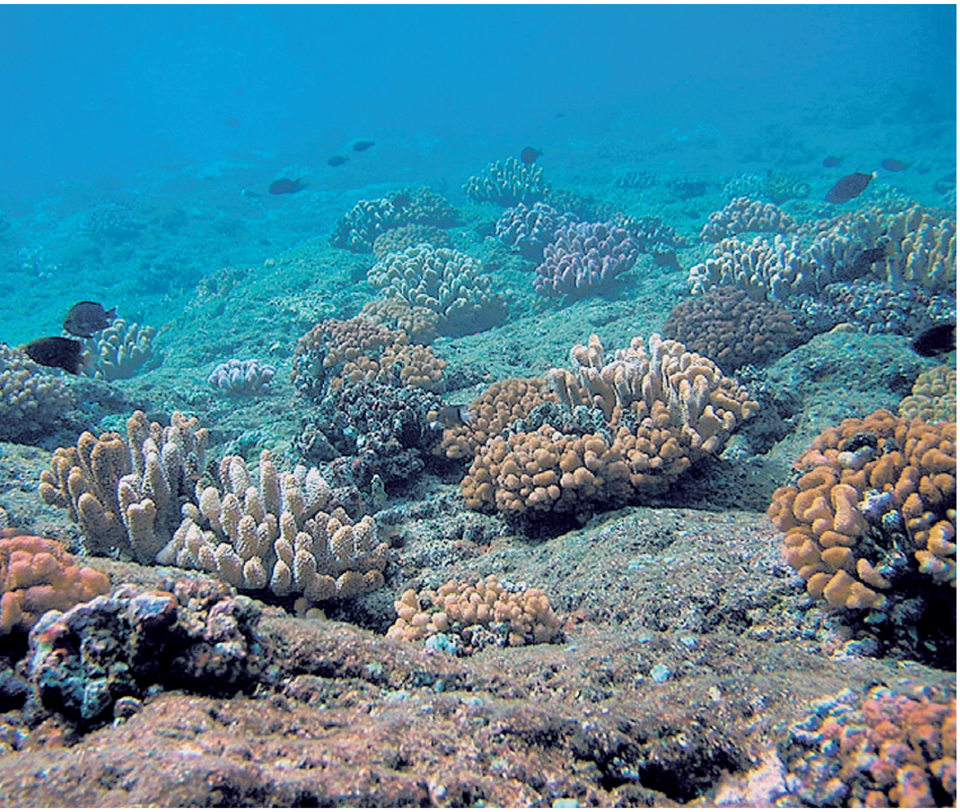
Figure 1

Living marine resources in the Exclusive Economic Zone (EEZ) of the United States are managed by NMFS. The EEZ is divided into five regions in this report.

This report primarily addresses the habitat use of commercially and recreationally harvested living marine resources and of protected species under NMFS jurisdiction. Harvested marine resources include various fish and shellfish. Protected species include marine mammals, sea turtles, and certain fish, invertebrates, and seagrasses. It is beyond the scope of this report to present a comprehensive review of the habitats used by all nearshore species. However, the report does highlight habitat use by some of the more important commercial and recreational species and groups that are managed by the states. Habitats of animals managed by federal agencies other than NMFS, such as sea otters and seabirds, are important components of marine ecosystems, but are not included in this report.

The habitats occupied by federally managed marine species range from inland streams used for spawning by anadromous species, such as salmon, to the entire U.S. Exclusive Economic Zone (EEZ) bounded by the 370 km (200 nautical mile [nmi]) limit (Figure 1), and beyond. This report provides a conceptual framework for understanding habitat-use patterns by the Nation's federally managed and protected species, identifying the shortcomings in relevant information, and describing how these shortcomings can be addressed through additional research.

The habitat needs of living resources compete with societal needs for the same areas. The difficult question of how much area to dedicate to fisheries' and protected species' habitats, as opposed to other uses, is increasingly coming to the forefront as coastal human populations increase such that habitat quantity is becoming more important as a limiting factor on species abundance. For example, partitioning of freshwater resources among competing interests can affect salmon that rely on upstream habitats for key life stages. The adjacent text box contains some essential concepts that must be considered by resource managers. As will be discussed throughout this report, enough habitat



Coral reef and fish in the Pacific Islands Region.

is needed to support every life stage of a species at levels sufficient to maintain populations and to allow flexibility to cope with the vagaries of nature during high-recruitment and/or low-resource years.

ECOSYSTEM-BASED APPROACHES TO MANAGEMENT

Over the past 10 to 20 years, there has been an evolution from management of single sectors and species toward the implementation of ecosystem-based management (EBM) of our ocean and coastal resources, including fisheries (Mooney, 1998; NMFS, 1999a; NRC, 1999; Link, 2010; WHCEQ, 2010; UNEP, 2011). A scientific consensus statement that describes EBM for the oceans can be found in the text box on the next page. In its basic form, the single-species approach to fisheries management relies on an assumption that abundance of a target stock is affected only by factors such as the abundance of its spawning adults, natural mortality, mortality caused by fishing, and the recruitment of juveniles to its population. This implies that the stock exists in isolation from the ecosystem in which it resides. These assumptions enable a mathematically tractable approach for stock assessment modeling and are appropriate for a single-sector decision-making process when environmental conditions are consistent. Other ecological and environmental factors can also affect the distribution and abundance of stocks, such as oceanographic conditions, predation rates, prey availability, competition, interactions with other species, habitat availability and condition, direct and indirect effects of climate change, and effects of other, non-fishing, human activities. Under EBM these factors also would be directly considered and analyzed when making management decisions, including those for fisheries.

NOAA is adapting its scientific methods and capabilities to meet the needs of ecosystem-based approaches to management. EBM should not be considered an add-on but rather a way to refine how we do business to be more efficient in marine resource management and to account for ecological and environmental factors more directly. EBM is still evolving, but generally embodies a more comprehensive and holistic philosophy. It includes a broader focus on ecological relationships and processes, and interactions with humans, such that a wide range of scientific disciplines is involved. EBM also includes a broader consideration of management tradeoffs by placing the management of natural resources, such as fish stocks and their habitats, into a broader context of societal priorities such as ecosystem services (e.g. improved water quality, scenery, employment, and economic activity).

There are many ways to characterize EBM. For example, as described by Murawski and Matlock (2006), EBM:

- is geographically specified;
- is adaptive in its development over time as new information becomes available or as circumstances change;
- takes into account ecosystem knowledge and uncertainties;
- considers the fact that multiple simultaneous factors may influence the outcomes of management (particularly those external to the ecosystem); and
- strives to balance diverse social objectives that result from resource decision-making and allocation.

Additionally, because of its complexity and emphasis on stakeholder involvement, Murawski and Matlock (2006) also describe the process of implementing EBM as needing to be:

- incremental; and
- collaborative.

The United Nations Environment Programme provides another example that includes descriptions of five core elements that are fundamental to EBM (UNEP, 2011). These elements are a useful illustration of the concepts underlying the still-developing field of EBM of coastal and marine resources, including fisheries. The five core elements are:

- recognizing connections among marine, coastal, and terrestrial systems, as well as between ecosystems and human societies;
- using an ecosystem-services perspective, where ecosystems are valued not only for the basic goods they generate (e.g. food or raw materials) but also for the important services they provide (e.g. clean water and protection from extreme weather);
- addressing the cumulative impacts of various activities affecting an ecosystem;
- managing for and balancing multiple and sometimes conflicting objectives that are related to different benefits and ecosystem services; and
- embracing change, learning from experience, and adapting policies throughout the management process.

NOAA's Integrated Ecosystem Assessment (IEA) Program

NOAA's IEA program[1] is developing into an effective tool to advance ecosystem-based approaches to management. The IEA approach is a decision-support system that uses diverse data and models to forecast future conditions and evaluate alternative management scenarios. Additionally, it assesses economic and ecological tradeoffs to guide decisions and implementation and evaluation of management actions relative to pre-determined objectives. This approach enables NOAA to manage resources to achieve ecological, economic, and societal objectives by providing a science-based framework for implementing EBM (Levin et al., 2012). Habitat, as a functioning element of ecosystems, is one of many important considerations when applying EBM and therefore conducting an IEA.

[1]See http://www.noaa.gov/iea/ (accessed March 2015).

"What is ecosystem-based management for the oceans? Ecosystem-based management is an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive, and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors. Specifically, ecosystem-based management:

- emphasizes the protection of ecosystem structure, functioning, and key processes;
- is place-based in focusing on a specific ecosystem and the range of activities affecting it;
- explicitly accounts for the interconnectedness within systems, recognizing the importance of interactions between many target species or key services and other non-target species;
- acknowledges interconnectedness among systems, such as between air, land, and sea; and
- integrates ecological, social, economic, and institutional perspectives, recognizing their strong interdependences."

—*Scientific Consensus Statement on Marine Ecosystem-based Management from McLeod et al. (2005)*

"CMSP is a comprehensive, adaptive, integrated, ecosystem-based, and transparent spatial planning process, based on sound science, for analyzing current and anticipated uses of ocean, coastal, and Great Lakes areas. CMSP identifies areas most suitable for various types or classes of activities in order to reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives. In practical terms, CMSP provides a public policy process for society to better determine how the ocean, coasts, and Great Lakes are sustainably used and protected—now and for future generations."

—*Final Recommendations of the Interagency Ocean Policy Task Force, July 18, 2010 (WHCEQ, 2010).*

In the Pacific Islands a current management initiative of the Kona, Hawaii, IEA is to provide scientific information to reduce interactions between pelagic longlines and insular cetacean stocks, particularly false killer whales and pilot whales. The Kona IEA has used cetacean satellite tagging data and oceanographic data to build species-specific models of forage habitat and spatial distribution. This has the potential to enable managers to forecast probability of whale presence and assess critical habitat, and to develop ecosystem-based protection measures. This approach could be expanded to any species for which satellite tagging data are available, thereby providing an ecosystem context for informing environmental assessments and project planning.

Coastal and Marine Spatial Planning

Coastal and marine spatial planning (CMSP) is an EBM-based planning process. The Interagency Ocean Policy Task Force that developed recommendations to enhance national stewardship of the ocean, coasts, and Great Lakes identified CMSP as a priority area in their recommendations (WHCEQ, 2010). CMSP offers a comprehensive, integrated approach to planning and managing competing uses and activities over the long term (see CMSP text box). CMSP emphasizes ecosystem-based approaches to management, ecological sustainability, and multi-disciplinary scientific information. The spatial domain identified for CMSP extends from the mean high-water line, through the territorial seas under the jurisdiction of states, out to the EEZ boundary and the Continental Shelf. Regional planning bodies are being implemented at the scale of regional ecosystems. The scope and scale of CMSP are designed to encompass and support NMFS' habitat mandates and the science requirements associated with them.

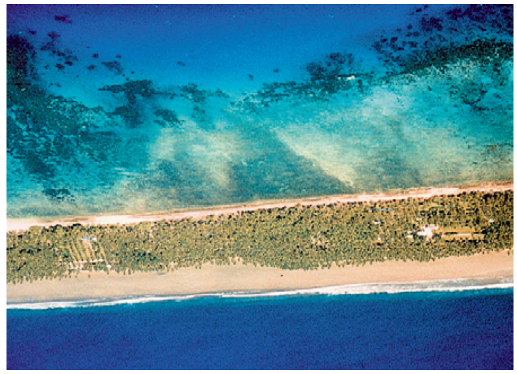
IMPORTANCE OF HABITAT FOR LIVING MARINE RESOURCES

Living resources are valuable assets of the United States. Part of this value can be measured in economic terms. In 2012, the most recent year for which global data are available, the United States was the world's third leading nation for commercial fisheries, with 5.6% of the world's landings. In 2013, landings by U.S. commercial fishermen (at ports within the 50 states) totaled 4.5 million metric tons (9.9 billion lb). These landings were valued at $5.5 billion (NMFS, 2014b). Living marine resources also generate considerable revenue. In 2013, U.S. consumers spent an estimated $86.5 billion on fishery products (including restaurant, industrial fish products, and other expenditures).

Another element of the value of living marine resources lies in recreation. In 2013, 11 million people made over 70 million recreational fishing trips in the continental United States, Hawaii, and Puerto Rico. The total catch was more than 430 million fish, with 61% being released alive. The total weight of the harvested recreational catch was estimated to be over 108,000 metric tons (239 million lb) (NMFS, 2014b). In addition, ecotouring activities, such as SCUBA diving and snorkeling on coral reefs and whale watching, are growing in the United States and worldwide.

An equally significant component of the value of living marine resources can be termed "ecosystem services." Fully functional marine ecosystems sustain and bolster the economic value of the habitats. Functioning marine ecosystems provide many services to humans, such as converting carbon dioxide, a leading greenhouse gas, to biomass through primary productivity; sustaining the marine food chains that support commercial and protected species; protecting coastal areas from storms and other marine hazards; and absorbing pollutants. In addition, the existence of marine species such as coral reef fish, sea turtles, and large whales, many of which are protected through legislation such as the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA), appeals to many people on an aesthetic or philosophical level. These marine resources and ecosystem services are clearly important to society, though their value is usually not reflected through traditional market prices. To quantify the value of marine resources and ecosystem services, non-market valuation tools are often used. These tools allow economists to quantify values for things like marine protected areas, threatened or endangered marine species, storm protection, or erosion control (Wallmo and Edwards, 2007).

Habitat is essential for maintaining healthy stocks of living marine resources and to support fully functional marine ecosystems. Minello et al. (2003) defined habitat as "all places that a population of a species (or life stage) lives." The Marine Fisheries Habitat Assessment Improvement Plan (NMFS, 2010) specifies marine habitat as the place where an organism lives as defined by its spatial and temporal distributions, which may include the physical, chemical, biological, and geologic components of both benthic and pelagic realms. This includes areas used for spawning, feeding, growth, and shelter from predators. Habitat structure may be of biotic or abiotic origin. Geological features are a key abiotic element of habitat. Examples include intertidal rocks, subtidal or deep-sea sediment, and seamounts that rise steeply from the deep-sea floor. Water itself is a critical abiotic component of the habitat for marine species. Attributes of seawater,



Richard B. Mieremet, NOAA

Aerial view of a coral atoll in the western Pacific Ocean showing the barrier reef (with terrestrial vegetation) separating the open ocean, to the outside, from the shallow lagoon on the inside.

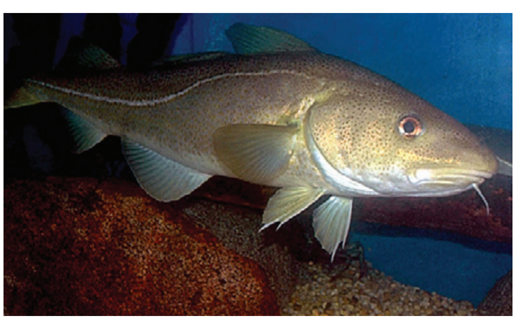
such as salinity (determined by the mixing of fresh and sea waters), play a major role in defining the habitat of estuarine species. Farther away from shore, ocean frontal zones, where distinct bodies of water meet, provide food-rich habitat for large pelagic predators, such as tuna. The biotic components of habitat consist of living or dead organisms. Some biotic components are of plant origin, such as salt marsh grasses, seagrasses, and kelp beds. Others are of animal origin, such as oyster bars and coral reefs. Some marine species can opportunistically occupy man-made habitats, including pier pilings and bridges, that attract encrusting invertebrates and fish. Sometimes old ships and other debris are deliberately sunk to provide artificial fish habitat and increased opportunities for successful fishing trips.

It is intuitively obvious that organisms require habitat, so one would expect that population sizes would be affected by habitat availability. This is often true, but the role of habitat in determining population size and distribution varies widely, and continues to be an active area of research. In some cases, there is a close relationship. For example, the blockage of access to upstream spawning habitat by dams has led to declines in many anadromous species such as salmon and shad. However, even in these cases, many other variables, such as reduced water flow, contaminants, and disease, also affect population sizes. Changing environmental conditions can also affect open-ocean habitats and result in population changes. For example, oceanographic regime shifts in the Pacific, which influence patterns of currents, water temperature, and primary productivity, can influence ocean survival of many species, such as Pacific salmon, and resultant popu-

> "One of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats."
>
> *—Excerpt from the Sustainable Fisheries Act (1996 SFA Pub. L. No.104–297, Title I, §101)*

lation sizes. Often, abundance–habitat relationships are difficult to clarify because other factors, such as variation in recruitment, abundance of prey or predators, environmental changes, pathogens, or fishing may also influence population size.

Habitat requirements can vary by species, life stage, and life-cycle activity such as spawning, breeding, feeding, or growth to maturity. Salmon, for example, require freshwater habitats to spawn, utilize estuarine habitats to varying degrees during their seaward movement, migrate to the ocean to grow, and eventually return to fresh water to complete their life cycle. Other organisms, like shrimp in the Gulf of Mexico, use tidal estuaries as nursery areas and oceanic habitats for spawning. Some species, at least at some life stages, are generalists, and can successfully exploit many different types of habitats. For example, while juvenile Atlantic cod are highly dependent on specific types of seafloor substrate as essential habitat, adult Atlantic cod typically occur over a wide range of bottom types.

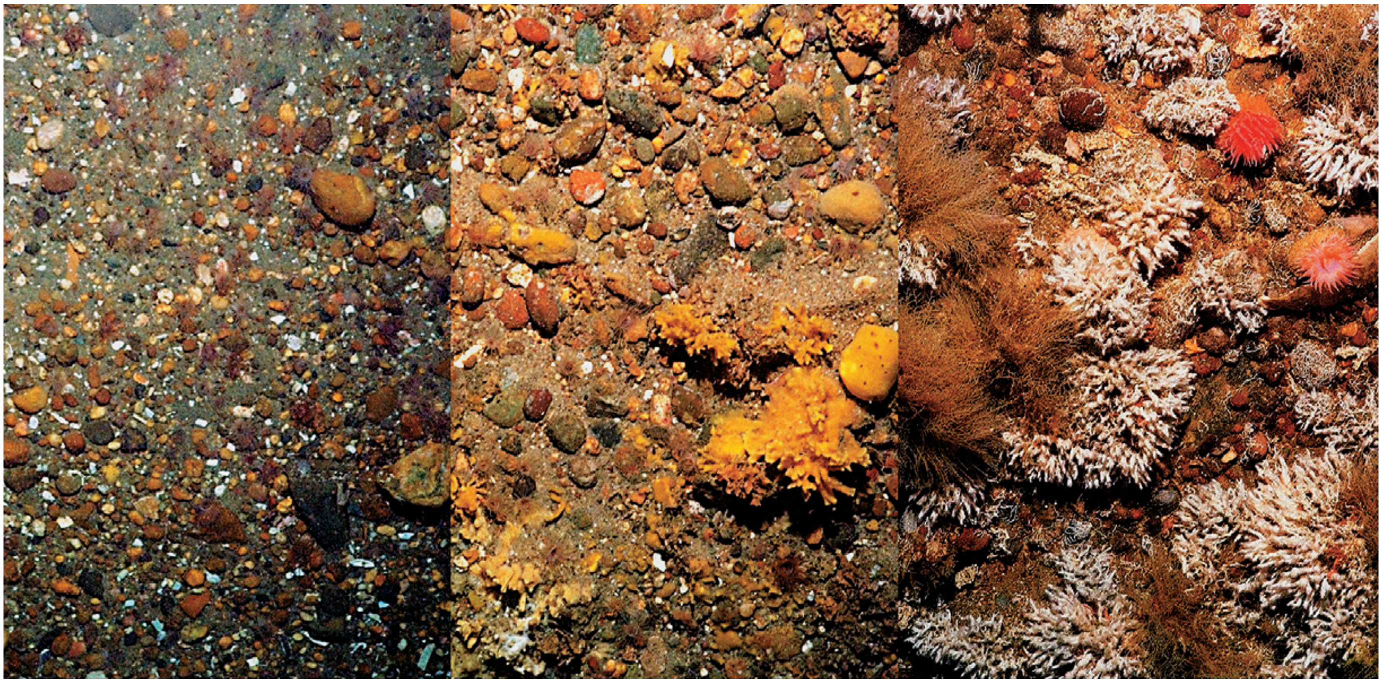

NOAA

An Atlantic cod in protective bottom habitat.

In contrast, some species are obligate habitat specialists. For example, several species of damselfish occur only in association with tropical coral reefs, so that any change in availability of coral-reef cover would result in a change in damselfish populations.

Habitat and habitat function can be impacted by naturally occurring stresses. Relatively short-term (and in some cases infrequent) events, such as storms, submarine landslides, and tsunamis, can damage or destroy habitat. Often the impacts last only a few years and rarely reach the deep seafloor. However, in some areas such as on barrier islands or in estuaries, relatively permanent changes can take place. For example, tropical or winter storms can scour out or cover seagrass beds with sand, carve a new inlet, or plug an old one. Submarine landslides are thought to play a major role in structuring habitat in sloping areas, such as along the edges of shelves and banks. Landslides on the slope off Oregon tremendously alter habitat, and some might equate this to destruction. However, at the same time these slides can create very large and structurally complex terrain that can be beneficial habitat for certain species of marine animals post-disturbance. Some naturally occurring cycles of climate variability, such as the El Niño–Southern Oscillation or the Pacific Decadal Oscillation, occur on time scales of a few years and also affect the distribution and condition of habitat. Other climate cycles, such as those associated with the ice ages and the advance and retreat of glaciers, last many thousands of years and can have global impacts on the distribution of habitat.

Habitat and habitat function also can be impacted by anthropogenic, or human-caused, stresses. Many are the obvious result of societal activities, such as the construction of dams that block access to spawning streams used by anadromous species, filling of salt marshes that serve as nursery areas for estuarine-dependent species such as some shrimp and flounder, or destruction of coral reefs that support a wide variety of organisms. Other habitat effects may be less direct and obvious but just as significant. For example, runoff from urban and agricultural areas or other sources can produce excessive input of nutrients, degrade water quality, and potentially result in a phytoplankton (algal) bloom. Depending on the extent and intensity of a phytoplankton bloom, bacterial decomposition of the excess phytoplankton can deplete dissolved



Page Valentine, USGS

Substrate at Northeast Peak in Georges Bank.

Left: Heavily disturbed gravel habitat that continues to be impacted by mobile fishing gear. Note that the gravel is clean, and that sand shows between the pebbles.

Middle: Recovering seafloor community. Note that there is some cover by epifauna, primarily sponges. The area had been closed 2.5 years.

Right: Undisturbed gravel habitat on the Canadian side of Georges Bank in an area characterized by scattered cobbles and boulders, which prevent access by mobile fishing gear. Note the nearly full cover provided by attached fauna.

oxygen so much that a fish kill occurs. For coral reefs, excess nutrients can act as fertilizers, stimulating vigorous growth of algae documented in many instances to have negative impacts on the slower growing corals. Sedimentation can also threaten sedentary marine organisms. For example, excess sediment can slow coral growth rates and weaken, or even kill, corals, depending on the quantity (Burke et al. 2011; Rogers, 1990). Additional examples of anthropogenic threats to habitat (e.g. marine debris, offshore energy development) will be discussed in greater detail in the National Summary chapter.

One notable anthropogenic threat to habitat addressed by NMFS is the impact of fishing on habitat and associated fish populations. Scientific theory and empirical evidence suggest that the impact is related to habitat type, fishing gear, and the frequency and intensity of both fishing activities and naturally occurring disturbances. Negative effects have been documented where fishing damages long-lived, slow-growing habitat structures on which certain species depend. For example, deep-sea coral that is damaged by trawling has an estimated recovery time of more than 30 years (Rooper et al., 2011). As shown in the above images, substantial bottom gear impacts to benthic substrate in the northwest Atlantic have been observed as a result of historical trawling activities. The northern edge of Georges Bank is, in a large part, covered by gravel of glacial origin where fishing activity is a major source of disturbance. As a result, unfished areas retain complex habitat characterized by abundant bushy epifaunal taxa, while disturbed areas have patchy or no epifauna, and expanses of bare substrate. Another example is the loss of the three-dimensional structure of oyster reefs, caused by the continual reworking of these reefs by dredges and tongs in Atlantic Coast estuaries. Oyster growth and survival are highest on the tops of these reefs, yet fishing has reduced many oyster reefs to thin veneers on the seafloor. In contrast, research in sandy areas lacking fragile, structure-forming biota, and characterized by frequent disturbance by waves or swift currents, has not identified a clear impact of fishing on seafloor habitats. Indirect impacts to habitat through trophic interactions as a result of reducing biomass of fishery species can also occur. For example, fishing for herbivorous species on coral reefs reduces grazing pressure on the reefs, which in turn can result in algal overgrowth and reduction of suitable settlement substrate for new corals.

Claire Fackler, NOAA, Natioal Marine Sanctuaries

A kelp rockfish taking shelter in the water column of a kelp forest in the Channel Islands National Marine Sanctuary. Many fish species rely on the shelter provided by kelp.

SUMMARY OF NMFS' RESPONSIBILITIES FOR HABITAT

Three major laws define NMFS' responsibilities: the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Marine Mammal Protection Act (MMPA), and the Endangered Species Act (ESA). All three contain provisions relevant to habitat. See Appendix 2 for a detailed list of the habitat-related laws for which NMFS is responsible.

Magnuson-Stevens Fishery Conservation and Management Act

Originally enacted as the Fishery Conservation and Management Act in 1976, the MSA is the primary legislation governing marine fisheries in the United States. The Act established eight regional fishery management councils to manage fisheries in the EEZ under fishery management plans (FMPs). FMPs may include one or several species, and are designed to achieve specified management goals for a fishery.

Essential fish habitat (EFH) provisions were added to the MSA through the 1996 Sustainable Fisheries Act (see text box on page 27). As stated in the Act: "One of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. Habitat considerations should receive increased attention for the conservation and management of fishery resources of the United States."[2] The legislation mandates that NMFS and the fishery management councils implement a process for conserving and protecting EFH. Three key features of this process are to 1) describe and identify EFH; 2) minimize adverse effects of fishing on EFH; and 3) consult on impacts of other activities on EFH.

Describe and Identify EFH—NMFS and the fishery management councils are required to describe and identify EFH for each life stage of the species included in their FMPs.[3] NMFS regulations also recommend that councils identify specific rare, sensitive, or ecologically important habitat types, called Habitat Areas of Particular Concern (HAPC). HAPCs are subsets of EFH that are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area.

Minimize to the Extent Practicable the Adverse Effects of Fishing on EFH—Councils must assess fishing impacts to EFH and minimize, to the extent practicable, the impacts of fishing on EFH. This may lead to fishing gear restrictions and time/area closures. In addition councils must identify other actions to encourage the conservation and management of EFH.

Consult on Impacts to EFH—Federal agencies are required to consult with NMFS when a proposed non-fishing activity may have adverse effects on EFH. In this consultation process NMFS provides recommendations to the other agencies. States are not mandated to consult with NMFS on purely state actions. However, many state actions also include federal actions, such as funding or the issuance of a federal permit. In such situations, NMFS would have to provide EFH conservation recommendations to the state that might include

[2]1996 SFA Pub. L. No. 104–297, Title I, §101.

[3]One FMP, the Consolidated Atlantic Highly Migratory Species FMP, is managed by the the Secretary of Commerce (through NMFS) giving the Secretary the responsibility to describe and identify EFH for these species.

Essential Fish Habitat (EFH)

What is EFH?

EFH is defined as "… those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" [MSA, 16 U.S.C. 1802(10)]. This terminology, broken down, refers to the following:

"Waters" refers to aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish, where appropriate.

"Substrate" refers to sediment, hard bottom, structures underlying the waters, and associated biological communities.

"Necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem.

"Spawning, breeding, feeding, or growth to maturity" refers to the stages representing a species' full life cycle.

EFH Levels

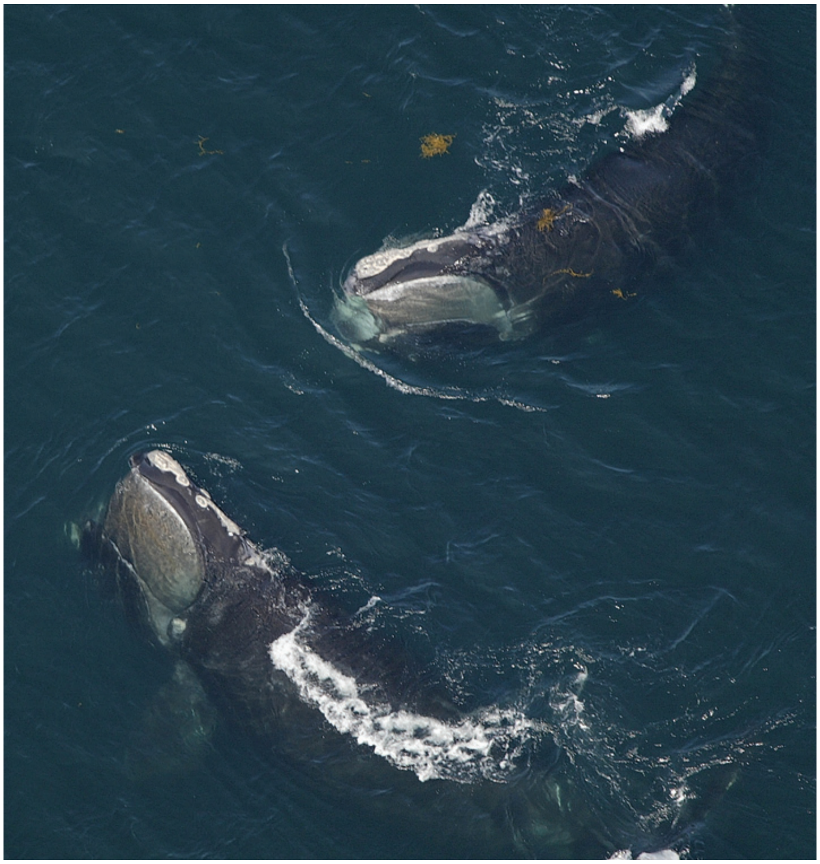
The EFH Final Rule issued on 17 January 2002 (NMFS, 2002) categorized the information available to support EFH designation into 4 levels that are summarized as follows:

Level 1: Distribution data are available for some or all portions of the geographic range. At this level, only distribution data (i.e. presence/absence) are available to describe the geographic range of a species (or life stage).

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 or life stage.

Level 3: Growth, reproduction, or survival rates within habitats are available. At this level, quantitative data are available on habitat-related growth, reproduction, and/or survival by life stage.

Level 4: Production rates by habitat are available. At this level, data are available that directly relate the production rates of a species or life stage to habitat type, quantity, quality, and location.


NOAA

North Atlantic right whales interacting in ocean habitat.

suggested actions to avoid, minimize, mitigate, or offset impacts to EFH. Like states, private entities are not required to consult with NMFS unless a proposed project may adversely affect EFH and is funded, permitted, or authorized by a federal agency.

Additional Habitat-Related Provisions—The MSA was reauthorized through the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA), which was signed into law in January 2007. The MSRA did not make any major changes to existing EFH legislation, but did contain some key provisions related to habitat. It authorized the creation of the Community-based Restoration Program for Fishery and Coastal Habitats to implement and support the restoration of fishery and coastal habitats. The program actively engages communities in on-the-ground restoration activities and emphasizes partnerships and collaborative strategies built around restoring NOAA trust resources and improving the environmental quality of local communities. The MSRA also established the Deep Sea Coral Research and Technology Program. To encourage EFH conservation and enhancement, the MSRA provided discretionary authority for FMPs to include designated zones to protect deep-sea corals from damage or loss due to fishery gear interactions. FMPs may also include conservation measures to protect non-target species and habitats.

Endangered Species Act and Marine Mammal Protection Act

The ESA and the MMPA define the protected-species mandates of NMFS. Under the ESA, NMFS is responsible for protecting marine species that are threatened with, or in danger of, extinction. Certain fish, invertebrates, sea turtles (when in the marine environment), marine mammals (cetaceans [whales, dolphins, and porpoises] and pinnipeds [seals and sea lions]), and marine plants are listed under the ESA. Listed seabirds, shorebirds, sea otters, walruses, manatees, and polar bears are managed separately by the U.S. Fish and Wildlife Service (USFWS) under the same or similar laws. NMFS and the USFWS share jurisdiction for conservation and recovery of sea turtles and anadromous species such as salmon. For these two groups, NMFS' jurisdiction is in the marine environment but extends into the riverine environment for salmon on the West Coast. USFWS' jurisdiction is in the riverine environment for salmon on the East Coast and on the nesting beaches of sea turtles on all U.S. coasts. Critical habitat must, to the maximum extent prudent and determinable, be designated for every species listed under the ESA (with the exception of some species that were on the original ESA list). As part of the ESA Section 7 consultation process,[4] NMFS issues Biological Opinions for federal actions that may adversely affect the critical habitat of ESA-listed species.

Under the MMPA, NMFS is responsible for protecting all species of cetaceans and pinnipeds (except walrus), regardless of their status under the ESA. This includes conducting studies

[4]Under Section 7 of the ESA, federal agencies must consult with NMFS or USFWS when an action the agency carries out, funds, or authorizes may affect a listed endangered or threatened species or its critical habitat.

of abundance, distribution, status, trends, and human-related impacts, and reviewing (and where necessary, revising) Marine Mammal Stock Assessment Reports every one to three years. When human-related impacts are identified that may cause declines or impede recovery of marine mammal stocks, NMFS is responsible for developing and implementing measures to alleviate these impacts on rookeries, mating grounds, feeding grounds, migratory routes, or in other ecologically significant areas.

NOAA's Habitat Blueprint

As evident from the mandates previously discussed, Congress has charged NOAA with managing the Nation's fish, threatened and endangered species, marine mammals, and other natural resources within the coastal zone. Recognizing that these mandates share a common thread, NOAA developed the Habitat Blueprint.[5] The Blueprint is a framework to think and act strategically across NOAA programs—to create healthy habitats that sustain resilient and thriving marine resources, help recover protected species, and protect coastal communities from storm damage. The Habitat Blueprint has a three-pronged approach that includes 1) establishing Habitat Focus Areas in each NOAA region where collaboration among NOAA's management and science programs and external partners can address multiple habitat-dependent objectives; 2) implementing a systematic and strategic approach to conducting habitat science that ultimately guides effective decision-making; and 3) strengthening policy and legislation at the national level to achieve meaningful habitat conservation results. The Blueprint will help guide NOAA's habitat strategy and actions going forward. Additional details on the Habitat Blueprint are provided in the National Summary chapter.

Other Mandates Related to Habitat

Several federal agencies and state and local governments participate in decisions involving conservation and protection of aquatic habitats. Whether explicitly focusing on conservation, issuing construction permits, conducting land-use planning, or undertaking infrastructure maintenance and development projects, many people with different objectives and values are involved in decisions that directly affect these habitats. Other major federal agencies outside of NOAA that deal with aquatic habitat-related conservation, restoration, and research include the Department of Defense (DOD), Department of Homeland Security (DHS), Department of the Interior (DOI), Environmental Protection Agency (EPA), Federal Energy Regulatory Commission, and the U.S. Department of Agriculture (USDA).

Recognition of the importance of habitat has led to many legal mandates to conserve and protect habitat (see Appendix 2 for a complete listing). When the actions of other federal agencies may impact the habitats of living marine resources, these agencies are often required to consult with NMFS and/or undertake other actions, depending on the applicable mandate. NMFS annually reviews several permit applications from the DOD's U.S. Army Corps of Engineers and other federal agencies that propose projects that may impact oceanic, coastal, estuarine, or riverine habitats vital to living marine resources. NMFS is involved in other consultation roles, such as those relating to power plant licensing (water quality, entrainment, and entrapment) and coastal-zone consistency reviews. These actions are subject to a number of procedural requirements.

Biogeography Team, CCMA, NOS, NOAA

A diver conducts ecosystem research in the Caribbean Sea.

[5]See http://www.habitat.noaa.gov/habitatblueprint/ (accessed March 2015).

Harbor seals hauled out and resting on rocks in Puget Sound, Washington.

In addition to the laws discussed above, which are under the jurisdiction of NMFS, there are three other notable U.S. habitat protection laws. The Clean Water Act aims to prevent destruction of aquatic ecosystems, including wetlands, by authorizing water quality and pollution research, providing grants for sewage treatment facilities, setting pollution discharge and water quality standards, addressing oil and hazardous substance liability, and establishing permit programs for water quality, point source pollutant discharges, ocean pollution discharges, and dredging or filling of wetlands. The National Environmental Policy Act requires federal agencies to analyze the potential effects of any proposed federal action on the human environment. Under the Federal Power Act, which regulates dams, NMFS can issue mandatory fish-passage prescriptions and recommend hydropower license conditions to protect, mitigate damages to, and enhance anadromous fish populations, including related spawning grounds and habitat. Other natural resource-related laws, such as the Fish and Wildlife Coordination Act, also contain sections pertaining to the protection of habitats. Please see Appendix 2 for an expanded listing of mandates that apply to habitat.

HOW MUCH HABITAT IS ENOUGH?

As habitat is lost due to development, pollution, fishing activities, etc., the number of fish and other marine species that the environment can support is reduced. Enough habitat must be maintained to support every life stage of a species at levels sufficient to maintain populations at the management target, be it maximum sustainable yield[6] or some other index. Determining how much habitat is needed to maintain a species or stock at a specific target level requires knowledge about a number of factors, including abundance; quantity, quality, and accessibility of available habitat and how stock dynamics are affected by these factors; fishing and other sources of mortality; impacts of climate change; etc. Moreover, this information is needed for all life stages.

Information on the amount of each habitat type needed for all the life stages of each species remains an ongoing challenge to quantify. At one end of the spectrum are species like Atlantic salmon that have been greatly reduced in abundance, in large part because of the loss of spawning habitat. In

[6]The largest average catch or yield that can continuously be taken from a stock under existing environmental conditions.

Benefits of Coastal Habitat for Community Resilience

Nationwide, there is strong societal and economic reliance on coastal resources such as wetlands, beaches, and estuaries. Effective management and restoration of these coastal resources is as critical to local economies as it is to ecosystem health.

The following are among the naturally protective benefits of coastal habitats and shorelines:

- Healthy wetlands protect communities from storm surges, filter runoff before it enters rivers and estuaries, provide food and nursery grounds for commercially important species of fish, and increase the value of the homes located nearby because of their scenic beauty. Coastal wetlands in the United States are estimated to provide $23.2 billion per year in storm protection services by serving as self-maintaining “horizontal levees” for storm protection (Costanza et al., 2008).

- Oyster reefs stabilize bottom sediments, reduce wave energy, and prevent erosion, which fortifies wetlands as a protective barrier (Stokes et al., 2012).

- Coral reefs also serve as natural barriers to storm surges that can cause great destruction to coastlines and communities. By one estimate, coastal protection accounts for $9.0 billion of the total $29.8 billion global net benefit of coral reefs (Cesar et al., 2003; Conservation International, 2008).

- Coastal barrier islands and dunes are natural lines of defense and an integral part of efforts to reduce risk from floods and storm surge (Grzegorzewski et al., 2011).

In the wake of recent coastal storm events such as Hurricane Irene and Superstorm Sandy, many coastal decisionmakers are looking toward practical, cost effective approaches to better incorporate the natural protective capacity of “green” (natural) infrastructure solutions in their communities. Incorporating these green infrastructure approaches can include promoting land conservation, wetland and dune restoration, living shorelines, and directing development away from naturally protective features and vulnerable areas.

this case it could be relatively straightforward to estimate how much more spawning habitat would need to be accessible to reach a target abundance, assuming other factors, such as downstream passage or climate change would not become limiting. However, for other species with low abundance, the relative contribution of habitat problems to the population decline is much less clear. At the other end of the spectrum are species that support large, healthy fisheries such as Atlantic sea scallops that have had minimal habitat loss. In this case, habitat is not likely to be limiting. Between these examples are many species that have been subject to heavy fishing (e.g. red drum) or incidental-take pressure (e.g. sea turtles), while also losing significant amounts of habitat to coastal development. While many factors can affect the abundance of living marine resources, a precautionary approach with respect to habitat protection can help sustain healthy stocks.


OAR/NURP

Spotted moray eel in coral habitat, Florida Keys.

Research will yield better information and lead to answers to the "how much is enough" question, enabling coastal and other managers to make informed decisions about tradeoffs between conservation of habitats for living marine resources and the development or maintenance of human infrastructure. There are many competing but legitimate demands on the habitats used by fish and protected species, such as coastal development, shipping, homeland security, agriculture, and waste disposal. Optimizing the use of habitat for any one purpose often reduces the options for other uses. Thus, effective management will require a comprehensive understanding of the effects of potential trade-offs.

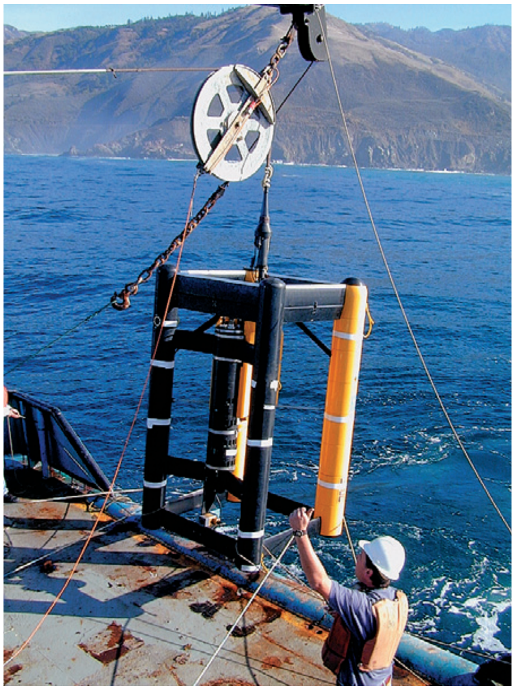
CURRENT STATUS OF THE SCIENCE UNDERLYING HABITAT ASSESSMENT, AND THE RELATIONSHIPS AMONG SPECIES, HABITATS, AND ECOSYSTEMS

Fulfilling the habitat mandates for managing living marine resources must be based on the scientific understanding of how species use habitat and how marine communities depend on the amount and condition of available habitat. As the scientific paradigm for living marine resource management shifts toward an ecosystem-based approach, habitat research will continue to be a vital component of this endeavor. To help guide development of a habitat science program for fishery species and other living marine resources, NMFS developed the Marine Fisheries Habitat Assessment Improvement Plan (NMFS, 2010). If fully implemented, this plan will help: 1) develop the habitat science necessary to meet the mandates of the Magnuson-Stevens Act and the economic, social, and environmental needs of the Nation; 2) improve NMFS' ability to identify essential fish habitat and habitat areas of particular concern and assess the impacts to these areas; 3) contribute to assessments of ecosystem services; and 4) contribute to ecosystem-based fishery management, integrated ecosystem assessments, and coastal and marine spatial planning. Although habitat science for protected species is not a focus of the Plan, much of the information that would be generated on fish habitat (e.g. maps) would also be relevant to protected species. NMFS may consider developing a habitat-science plan for protected species in the future.

From the perspective of sustainable management of living marine resources, habitat research may be distilled into a series of fundamental questions. The following five sections address these questions.

How Do Species Use Habitat?

Most marine species undergo complex life cycles, so their use of habitat can vary widely over the course of their lives. Thus, quantity and quality of habitat for every life stage can potentially affect species abundances and distributions. Accordingly, research to determine habitat use requires sampling appropriate for every life stage. For example, the typical fish life begins with an egg, which may be as small as 1 millimeter (0.04 in). Depending on the species, the egg may develop internally within the parent, externally in a free-floating form, or attached to a substrate. Research to determine habitat use by eggs would require sampling the water for plankton, or identifying and sampling the specific substrate. After days to months, the egg hatches, releasing a larva that is usually free swimming, often drifting with the currents and tides. Most fish larvae are on the order of millimeters to centimeters in size. Research to document habitat use by this stage would also require plankton sampling. However, many larvae are active swimmers capable of avoid-



Santa Cruz Laboratory, NMFS

Santa Cruz Laboratory, NMFS

Left: A laser line scanner integrated with a tow body is deployed off Big Sur Coast, California, to image seafloor organisms and habitats.

Right: A scan image of fishes around a 4 m (13 ft) high rock outcrop with white sea anemones off Big Sur Coast, at a 60 m (200 ft) depth, taken by the scanner in the left photograph.

ing some plankton samplers. The larva undergoes metamorphosis into a juvenile, which may live in the water column for several months to years, or become associated with the seafloor. Conducting research on habitat use by juveniles may require larger gear, such as trawls, traps, or imaging systems such as video cameras. As the juvenile grows and matures, it may migrate to different geographic regions, depths, and bottom types for feeding, predator avoidance, or spawning. As with the other life stages, research must be tailored to the appropriate habitat types and geographic scales.

Our knowledge of how the various species use habitat during each of their life stages is most refined for species of relatively high economic value that have been studied for many decades. For many other species, we know only whether they are present or absent from a given area, and we may not even know that for all life stages.

What is the Quantity of Usable Habitat?

Understanding the impacts of habitat on populations, communities, and ecosystems requires knowledge of how much habitat exists, how much of that habitat is in a condition that will support a particular species of interest, and how that habitat persists through time. These three components are related, but have distinct information requirements.

Habitat quantity and distribution are determined by a variety of survey methods that can vary depending on the types and locations of the habitats, and on the scale of the information required. Surveys employing hand sampling may be appropriate for marshes and wetlands, while small boats or divers may be needed for estuaries and shallow areas close to shore. In the open ocean, modern research ships, and sometimes aircraft, with oceanographic instrumentation are required. Many high-tech, remote-sensing technologies, including satellites, are available for economical and accurate large-scale surveys, or surveys of inaccessible or deep areas. These include acoustic methods such as multibeam and sidescan sonar, and optical methods such as aerial photography, multispectral and laser-line scan imagery, and video. All of these methods provide data that can be used in scientific analyses and management decision-making.

NMFS is taking many steps, including publishing this report, to determine the distribution and amount of fisheries habitat and how it is used by various species. However, only a small percentage of the U.S. EEZ seafloor has been characterized, and

Coastal and Marine Ecological Classification Standard (CMECS): Using Common Terminology for Describing Ecosystems

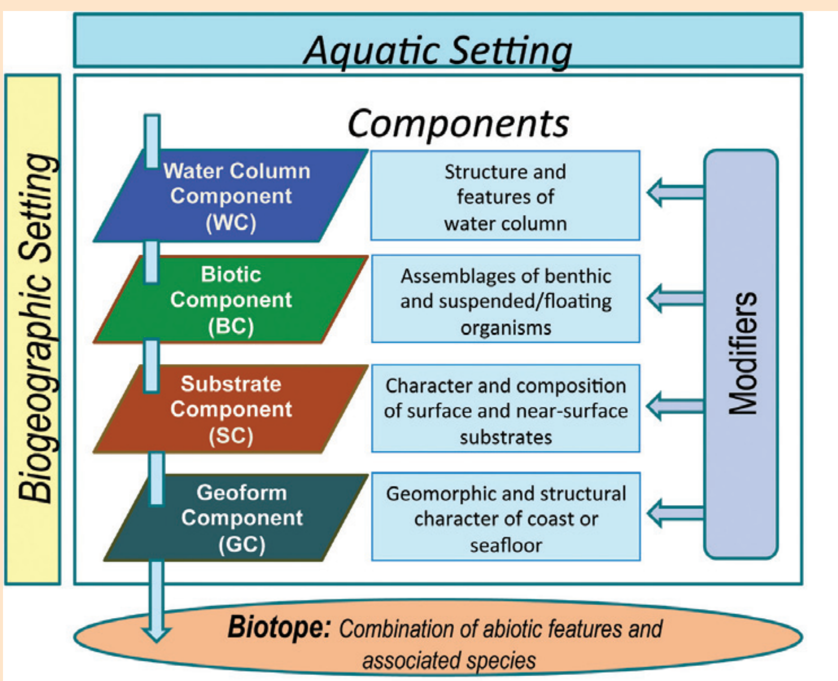
NOAA has been a leader in interagency efforts to develop and gain Federal Geographic Data Committee (FGDC) endorsement for CMECS—the first-ever comprehensive federal standard for classifying and describing coastal and marine ecosystems. CMECS provides a simple, standard framework and common terminology for describing and organizing information about coasts and oceans and their living systems.

CMECS Benefits

- applies regardless of collection methods and instruments—sensor independent;
- applies across spatial scales—e.g. from benthic grabs to satellite imagery;
- accommodates biological, geological, chemical and physical data;
- includes water column features and habitats; and
- revises readily to accommodate new information.

CMECS Status

NOAA is working to implement CMECS within the agency, across other elements of the Federal Government, and with state, regional, and local governments, nongovernmental organizations (NGOs), industry, and academia. For more information, see http://www.csc.noaa.gov/digitalcoast/publications/cmecs (accessed May 2015).



our understanding of dynamic pelagic (open water) habitats is similarly limited. Nevertheless, the amount of scientific information available on the dynamic oceanographic and biological processes that characterize open-water habitats continues to grow, particularly in a few well-studied areas such as the Gulf Stream, California Current System, Shelikof Strait, and Georges Bank.

Most marine organisms have some level of habitat specificity. Most species require a suite of conditions in terms of suitable food, living space, protection, and reproduction. Even within a range of what appears to be suitable habitat, many portions often are not usable due to microscale factors affecting the seafloor; water characteristics such as flow, temperature, and salinity; or other factors that may not be known. The only way to determine whether or not a habitat is suitable, and how often it is being used, is to conduct sampling at appropriate spatial and temporal scales to quantify the distribution and abundance of the organisms and the associated habitat variables.

A system of classifying, or defining and naming, habitat types is a prerequisite for quantifying habitat. In 2012, the Federal Geographic Data Committee endorsed the Coastal and Marine Ecological Classification Standard (CMECS) as the first comprehensive federal standard for classifying and describing coastal and marine ecosystems (USGS, 2012; see the CMECS website for further information[7]) CMECS offers a simple, standard framework and common terminology for describing natural and human-influenced ecosystems from the upper tidal reaches of estuaries to the deepest portions of the ocean. The unifying framework is organized into two settings, biogeographic and aquatic, and four components: water column, geoform, substrate, and biotic. Each describes a separate aspect of the environment and biota. Settings and components can be used in combination or independently to describe ecosystem features. The CMECS system is hierarchical, so that it can be used to quantify habitat at different levels of detail and to develop habitat characterizations over a range of spatial and temporal scales (see the CMECS text box on the next page for additional information).

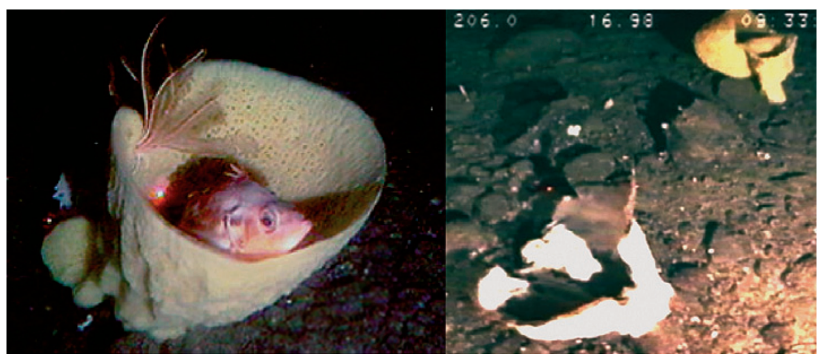
[7]http://www.csc.noaa.gov/digitalcoast/publications/cmecs (accessed March 2015).

What Factors Affect the Quantity and Quality of Available Habitat?

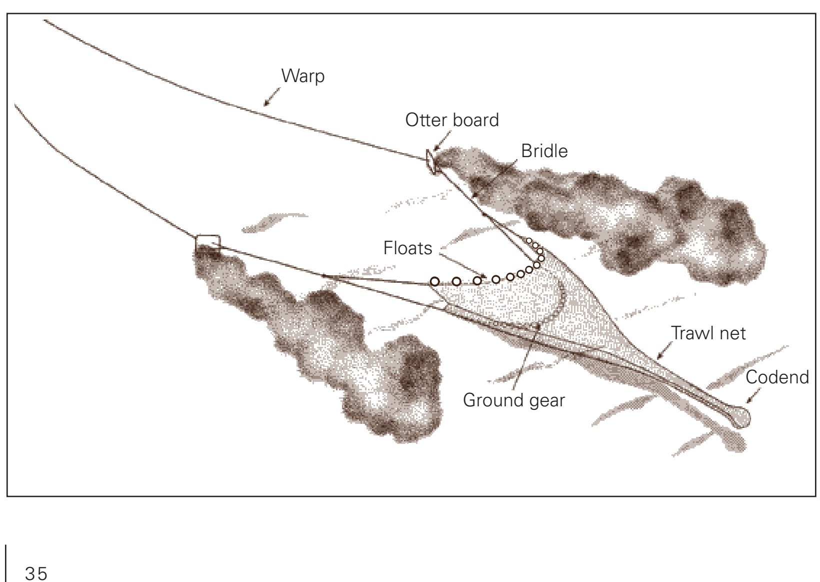
The widespread fragmentation, loss, and degradation of habitats have been caused by a variety of anthropogenic and natural factors. Anthropogenic factors that can affect habitat quality or quantity include agriculture, coastal development, dams, fishing, grazing, invasive species, water withdrawals, logging, mining, pollution, urbanization, and vessel traffic, among other activities. These activities impact aquatic environments through habitat alteration such as a change in water flow that restricts organism movement, or by actual habitat removal or destruction. For example, fishing methods such as bottom trawling can cause long-term damage to some types of seafloor habitat, especially those dependent on fragile and/or slow-growing biogenic structures such as deep-sea corals. Natural factors such as climate variability may also impact habitats. For example, winter storms can cause significant

In the photographs below, both from the Gulf of Alaska, the left image shows how an intact sponge provides fish habitat and protection; the right image shows how these fragile structures can be damaged by mobile fishing gear, such as trawls or dredges.

The illustration below (adapted from FOOCG, 2001) shows a bottom trawl during fishing operations. The metal otter boards (doors) and floats on the headrope spread the trawl open horizontally and vertically, respectively. The doors, bridles (sweeps), and groundgear contact with the seabed.



Auke Bay Laboratory, NMFS



Dan Howard, NOS

A nutrient-rich mud flat at California's Tomales Bay.

seasonal disturbance to kelp bed habitats. El Niño and La Niña events can alter environmental factors, such as precipitation and ocean currents, and cause major changes in habitats throughout Pacific ecosystems. This results in major changes in the abundance and distribution of both predators and prey, as well as shelter sites. Additionally, sea level rise continues to impact coastal marshes and wetlands, particularly in areas subject to land subsidence. More details are provided on these factors in the National Summary and in the regional chapters.

Efforts to improve coastal and river water quality have had significant success through reductions in raw sewage inflows and improved land-management practices that reduce erosion and sediment loads, among other factors. Still, there are persistent and increasing problems. Among them are excess nutrients, residual contamination from now-prohibited activities, loss of coastal wetlands, and continued coastal development. Research is directed at determining and monitoring the status of habitats to determine any changes in habitat quality or quantity over time and to find methods to reduce and repair damaged areas. Such research efforts will be discussed in more detail later in the report. In addition, actions by NMFS and the fishery management councils to address gear impacts to benthic habitats have the potential to significantly decrease the future loss of certain habitats due to fishing impacts. Examples can be found throughout the United States, ranging from the West Coast where bottom trawling was prohibited in designated waters to help safeguard the habitat of groundfish, to the Southeast Region where five Habitat Areas of Particular Concern were recently established for deep-sea coral protection and include prohibitions on the use of most types of fishing gear that contact the seafloor.

How are Species Abundances Affected by the Quantity and Quality of Habitat?

The linkage between habitat and fisheries productivity has long been reported and is an ongoing area of research. Such information, if available, can support and improve fisheries management. Numerous confounding factors, as described above, can make it difficult to understand the direct role of habitat in affecting species abundances. Further, some organisms require specific types of habitat, while others can utilize or adapt to a wide range of environments. Various habitats, disturbed or pristine, may have different values to certain species. What degrades a particular habitat for one suite of species may improve habitat for different suites of species. An additional complication is that habitat function can vary geographically or under changing environmental conditions, such as different climactic, salinity, or tidal regimes.

Nonetheless research has identified many direct linkages between habitat and fisheries productivity. Many studies examining the role of wetlands as nurseries have concluded that seagrass beds, salt marshes, and mangrove forests provide important support for juvenile fish and invertebrates (e.g. Beck et al., 2003). Other studies have shown that oyster reefs support a high density, biomass, and richness of estuarine fish species in comparison to other habitat types (e.g. Stunz et al., 2010). Additional research has demonstrated that productivity of blue crabs and brown and white shrimp in marsh habitats is considerably higher than in open water habitats (Minello et al., 2008), further showing the value of salt marshes in supporting the productivity of these commercially important species.

Several literature reviews also provide further insights. Heck et al. (2003) summarized the results of over 200 papers dealing with the importance of seagrass meadows. Their results indicated that seagrass is more productive than unvegetated habitat, producing numbers, growth, and survival of im-

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Scott Johnson, NMFS

Habitat areas that are important as fish nurseries: upper left, salt marsh; upper right, seagrass; lower left, oyster cobbles; lower right, kelp bed.

portant species similar to those produced by other structurally complex ecosystems, such as oyster or cobble reefs and kelp beds. Another review (Minello et al., 2003) found that, based on fish density, the value of ecosystems as nurseries could be ranked from first to last in the following order: seagrass, vegetated marsh edge, non-vegetated marsh, open water, macroalgae (seaweed), oyster reefs, and vegetated inner marsh. Another review (Sheridan and Hays, 2003) concluded that intertidal mangroves can be as important in supporting high fish and invertebrate densities as other structured habitats such as seagrasses or salt marshes. These reviews yield valuable insight to resource managers and to scientists, greatly furthering our understanding of the importance of different habitat types. Additional research that can identify linkages between habitat and species productivity, as well as longer-term data sets that track the productivity of a habitat over time, will further help managers understand critical connections between species abundances and habitat quantity and quality.

How Can the Structure and Function of Degraded Habitat Be Restored?

As habitat loss remains a growing problem for coastal and estuarine areas of the United States, restoration has become an important conservation practice. From restoring fish habitat such as salt marsh and coral reefs to building oyster reefs and planting mangroves to protect the coast from erosion and flooding, the science behind restoration is as diverse as the habitats themselves.

NOAA collaborates with partners and provides technical assistance on engineering, site evaluation, restoration planning, monitoring, and environmental compliance to ensure effective design and implementation of restoration projects (see the NOAA Restoration Center's website for more details[8]). Some of NOAA's restoration efforts depend on volunteers, such as NOAA's Community-based Restoration Program. There are several examples

[8]http://www.habitat.noaa.gov/restoration/ (accessed March 2015).

What is Restoration?

"The return of an ecosystem to a close approximation of its condition prior to disturbance . . . . Both the structure and functions of the ecosystem are recreated. Merely recreating a form without the functions in an artificial configuration bearing little resemblance to a natural form does not constitute restoration. The goal is to emulate a natural, self-regulating system that is integrated ecologically with the landscape in which it occurs."

—Definition of restoration from the National Research Council report "Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy" (NRC, 1992).

of NOAA-supported restoration efforts. NOAA recently participated in the Elwha River Floodplain Restoration Project to help restore habitat of protected salmon species in the Pacific Northwest. Restoration activities began soon after the removal of the first of two obsolete hydroelectric dams slated for deconstruction on the Elwha River, which began in 2011, and included the removal of dikes and invasive species and the planting of native species. NOAA also helped restore shoreline and critical barrier island habitat in Louisiana's Barataria Bay to help prevent shoreline breaching and to protect and create dune, swale, and intertidal marsh habitats. By restoring barrier islands, wetlands, and other habitats that buffer impacts of floods and storms, NOAA also helps to build hazard-resilient coastal communities.

Restoration, however, is not simply the physical construction of a particular habitat type in a specific location. The fundamental goal of aquatic ecosystem restoration is to return disturbed habitat to a condition that resembles its natural pre-disturbed state. Achievement of this goal entails restoration of the target ecosystem's structure and function, both locally and within its broader landscape or watershed context. To measure the degree of success in achieving restoration goals, physical, chemical, and biological data are necessary to verify that a restored habitat is functioning as intended. To achieve long-term success, aquatic ecosystem restoration should address the causes and not just the symptoms of ecological disturbance. In some situations a restoration plan must consider what is acceptable under existing social, political, economic, and engineering constraints.

ORGANIZATION OF THIS REPORT

This report summarizes the available information, as well as the gaps in this information, on the relationships between the productivity of living marine resources and habitat. The purpose is to educate scientists, managers, and the interested public, and to help improve and support fishery management and conservation efforts. Inadequate scientific information can make it difficult to identify the habitats most critical to the growth, reproduction, and survival of federally managed species, and therefore to designate EFH and critical habitat. As a consequence, areas may be inadequately defined because of uncertainty regarding the types and range of habitats necessary to sustain marine species. Thus, identifying information gaps is also an important contribution to improving management and conservation.

The next section, the National Summary, presents an overview of status and trends in habitat use and information quality for federally managed and protected living marine resources, and highlights national habitat issues, trends, and research needs.

Following the National Summary, the report is divided into five regional chapters: Northeast, Southeast, Pacific Coast, Alaska, and Pacific Islands (Figure 1, Table 1). These regions are based on geography and are generally similar to the NMFS regional structure. All the report's regions extend from the upper reaches of watersheds utilized by anadromous fishes to the U.S. EEZ boundary, which is either an international boundary (e.g. with Canada or Mexico), or 370 km (200 nmi) off the U.S. coast. It should be noted, however, that most

Table 1 Characteristics of geographic regions used in the *Our Living Oceans: Habitat* report.

Region in OLO Habitat report	Geographic extent	NMFS fisheries science centers	Fishery management councils
Northeast	From the U.S.–Canada border (Maine–New Brunswick) to Cape Hatteras, North Carolina	Northeast Fisheries Science Center, Woods Hole, Massachusetts	New England FMC Mid-Atlantic FMC
Southeast	From Cape Hatteras, North Carolina, to the U.S.–Mexico border (Texas–Tamaulipas); also Puerto Rico and U.S. Virgin Islands	Southeast Fisheries Science Center, Miami, Florida	South Atlantic FMC Gulf of Mexico FMC Caribbean FMC
Pacific Coast	From the U.S.–Canada border (Washington–British Columbia) to the U.S.–Mexico border (California–Baja California)	Northwest Fisheries Science Center, Seattle, Washington Southwest Fisheries Science Center, La Jolla, California	Pacific FMC
Alaska	Alaska	Alaska Fisheries Science Center, Seattle, Washington	North Pacific FMC
Pacific Islands	Hawaii, Northwest Hawaiian Islands, and several small island territories extending nearly as far west as Japan and to nearly 20 degrees south of the Equator	Pacific Islands Fisheries Science Center, Honolulu, Hawaii	Western Pacific FMC

states have jurisdiction over waters from the mean lower low water line at the coast out to 5.6 km (3 nmi). The exceptions are Texas, Puerto Rico, and the Gulf Coast of Florida, which have jurisdiction out to 16.7 km (9 nmi) from the coastline. The distributions of some highly migratory fish and marine mammals extend into the territorial seas of other countries and/or into the international waters of the open ocean.

Four primary habitat categories are used in this report. They are defined in Table 2: freshwater, estuarine, shallow marine, and oceanic habitat. These broad habitat categories incorporate more specific habitat types such as seagrass beds, rocky intertidal zones, coral reefs, mangrove forests, kelp forests, mud flats, marshes, hard shell and sandy bottoms, the open water column, and numerous others.

Each regional chapter includes descriptions of the region's geographic areas, an in-depth look at the four habitat categories, descriptions of habitat use by federally managed fishery and protected species and key examples of state-managed species, a summary of habitat trends, and an overview of the research needs for that region. Descriptions of habitat use by federally harvested marine species are organized by fishery management plans. At the time this report was developed, there was a combined total of 46 fishery management plans and fishery ecosystem plans (See Appendix 3 for a full listing). Descriptions of habitat use by protected species are grouped by cetaceans (whales, dolphins, and porpoises), pinnipeds (seals and sea lions), sea turtles, or other categories as appropriate. Please see Appendix 5 for a full listing of fishery and protected species included in the report.

Examples of the four habitat categories: upper left, freshwater habitat (Alaskan stream); upper right, estuarine habitat (Grand Bay, Mississippi); lower left, shallow marine habitat (Point Dume, California); lower right, oceanic habitat (Atlantic Ocean).

NOAA

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Table 2 Definition of the habitat categories used in the *Our Living Oceans: Habitat* report.

Category	Definition	Examples
Freshwater habitat	Habitats located between headwater and head-of-tide, with negligible salinity. (Headwater is the inland source from which a river originates; head-of-tide is the inland limit of water affected by tides.)	Columbia River, Penobscot River, Togus Stream, Bond Brook (latter two are Kennebec River tributaries)
Estuarine habitat	Habitats located in a semi-enclosed coastal body of water extending from head-of-tide to a free connection with the open sea, within which sea water is mixed with fresh water.	Chesapeake Bay, Puget Sound
Shallow marine habitat	Habitats less than 200 m (656 ft) in bottom depth, located between the outer boundary of an estuary or coast (continent or island) and the outer boundary of the U.S. EEZ, which is usually 370 km (200 nmi) from shore. This includes the seafloor and open water column over areas shallower than 200 m.	Continental Shelf habitats, fringe and barrier reefs, atolls (e.g. Johnston Atoll), Gulf of the Farallones, Heceta Bank
Oceanic habitat	Habitats greater than 200 m (656 ft) in bottom depth, located between the outer boundary of an estuary or coast (continent or island) and the outer boundary of the U.S. EEZ. This includes the seafloor and open water column over areas deeper than 200 m.	Continental Slope habitats, Bear Seamount, Hudson Canyon, Gulf of Maine basins, Monterey Canyon, abyssal plains

Habitat—What is it worth?

It is easy to understand why healthy coastal and marine habitat is important for fish and wildlife, but what value do we place on these habitats for ourselves? Though we often take it for granted, nature plays a significant role in our lives, whether we are eating seafood from a nearby estuary or vacationing at our favorite beach—two examples of benefits we receive from healthy coastal and marine ecosystems. Today, you might hear these benefits referred to as ecosystem services.

We conserve habitat to make sure these ecosystem services are available for healthy coastal communities and future generations. The work of conserving habitat makes a positive contribution to our economy by generating "green" jobs and making sure coastal resources are available for industries such as fishing and tourism.

What is our role?

With healthy habitat under threat nationwide, we can no longer take ecosystem services for granted. Our goal is to enhance coastal resource management decisions by demonstrating the social and economic contributions of healthy habitat with respect to the following factors:

- coastal and marine resources;
- commercial, recreational, and non-market economic activities;
- the health and safety of the Nation's citizens; and
- protecting property and communities.

Local communities find value in restoring the Elwha River

An example of research on the value of restoring ecosystem services is developing in Washington State. The Elwha River will be restored to its natural state following the removal of two large dams that began in 2011 and was completed in 2014. During this time 33.2 hectares (82 acres) of riparian zone (non-wetland) habitat were restored. NOAA's Elwha River and Floodplain Restoration Project includes three discrete project areas: 1) restoration of floodplain habitat in the lower Elwha River; 2) native plantings and control of invasive plants that support dam removal actions; and 3) initiation of long-term monitoring of adult fish populations in the Elwha River. With funding from the Estuary Restoration Act, NOAA is conducting an ecosystem services valuation survey to estimate recreational and passive-use values for the restored river and flood plain. The study will provide answers to the following three questions:

1. What is the effect on the public's welfare from dam removal and flood plain restoration?
2. What is the value of preserving key endangered or threatened species?
3. What are the potential changes in recreational use from river restoration?

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