

# The Habitat Research Plan of the National Marine Fisheries Service

By Gordon W. Thayer, James P. Thomas, and K. V. Koski

Mark Fonseca/NMFS Beaufort Lab



NMFS researchers are studying ways to restore sea-grass habitat and evaluate the rates of habitat recovery, including faunal use of these restored habitats.

## ABSTRACT

A responsibility of the National Marine Fisheries Service (NMFS) is to develop the necessary understanding, using basic and applied research and literature syntheses, to help conserve, protect, and restore habitats of living marine resources. The NMFS National Habitat Program has developed a Habitat Research Plan to direct and conduct research and transfer results to management components within the NMFS that are involved in permit reviews, development of habitat sections of Fishery Management Plans and protected species Recovery Plans, and development of restoration options and plans as part of the Natural Resources Damage Assessment claims. The plan aims to develop the necessary expertise to oversee restoration, creation, or acquisition of habitat to benefit living marine resources. This plan gives guidance in four areas: ecosystem structure and function, effects of alterations, development of restoration methods, and development of indicators of impact and recovery. The plan also emphasizes a fifth area—the need for syntheses and timely distribution of scientific information to managers. The plan is designed not only as an umbrella document under which to organize habitat research within the NMFS but also as a guide that can and will be modified as habitat issues and responsibilities change.

**T**he National Marine Fisheries Service (NMFS), an agency of the National Oceanic and Atmospheric Administration (NOAA), is the principal steward of living marine resources (LMRs) in the United States. Resource viability depends in part on habitat protection, maintenance, and restoration. Habitat loss to pollution and development is among the greatest long-term threats to the future viability of U.S. fisheries (Burns 1991; Brouha 1993; Waste 1996). The NMFS has established a National Habitat Program whose goal is to conserve, protect, and restore the valuable habitats needed to sustain marine and anadromous communities. In the past, the agency has worked toward conservation, protection, and restoration of habitat by reviewing licensing, permitting, and legislative and administrative activities that affect LMRs and habitats; coordinating with regional fishery management councils on fishery

*Gordon W. Thayer is leader of the Fishery Habitat Utilization and Protected Resources Team and habitat coordinator for the Southeast Fisheries Science Center, Beaufort Laboratory, Beaufort, NC 28516; gthayer@hatteras.bea.nmfs.gov. James P. Thomas is West Coast and Northeast Regional Team leader, NOAA/National Marine Fisheries Service (NMFS) Office of Habitat Conservation, Restoration Center, Silver Spring, MD 20910; james\_thomas@ssp.nmfs.gov. K. V. Koski is a fishery research biologist and habitat restoration team leader, NOAA/NMFS Alaska Fisheries Science Center, Auke Bay Laboratory, Juneau, AK 99801; k\_koski@ccgate.ssp.nmfs.gov.*

management plans; and conducting habitat research. In the context of this plan, we are using *habitat* to include not only the physical, chemical, and biological environment of an organism but also the processes occurring within that environment.

The NMFS is restructuring the National Habitat Program to meet current and evolving demands and responsibilities regarding habitat and fisheries management and protection of threatened and endangered species in coastal and estuarine areas. The agency also has created a coordinated research guidance plan and approach to support its habitat-related mandates as part of the program. The Habitat Research Plan (HRP) was developed with input from scientific and management personnel at both the headquarters and field levels. The plan (1) provides a framework to conduct coastal and estuarine research and transfer results to those management components involved in permit reviews, development of the habitat sections of Fishery Management Plans and protected species Recovery Plans, and development of restoration options and plans as part of the Natural Resources Damage Claims (under the Comprehensive Environmental Response, Compensation, and Liability Act, Oil Pollution Act, and Clean Water Act); and (2) leads to development of the necessary expertise within NMFS to identify habitat impacts and accomplish and oversee the restoration, creation, or acquisition of habitat to benefit LMRs. This paper describes the agency's Habitat Research Plan.

## Background

Numerous statutes and international conventions and treaties authorize the NMFS mission to conserve and restore marine habitat, including the Magnuson Fishery Conservation and Management Act; Endangered Species Act; Fish and Wildlife Coordination Act; National Marine Sanctuaries Act; Clean Water Act; Comprehensive Environmental Response, Compensation, and Liability Act (Superfund<sup>®</sup>); and Oil Pollution Act (Waste 1996). These laws and policies foster conservation of LMRs and their habitats to benefit society without jeopardizing options for the future.

The NMFS is highly cognizant of the delicate balance among conserving, protecting, and using LMRs to benefit society. Indeed, one principal goal of the NMFS Strategic Plan is to "protect LMR habitat" using the following four objectives (Waste 1996):

- (1) Use legal authority to implement a cohesive strategy to protect and restore habitat.
- (2) Assess the effects of habitat modifications and contaminants on populations of LMRs.
- (3) Determine if artificial or restored habitats fulfill essential needs of LMRs.
- (4) Restore depleted stocks affected by habitat modifications.

Living marine resources contribute substantially to the U.S. economy. More than 70% of the commercial fish (by weight) harvested in the United States—worth \$19.8 billion (in value added) to Gross National Product in 1993 (U.S. Department of Commerce 1994)—depend on coastal, estuarine, and riverine habitat for food, shelter, spawning, and migration (NMFS 1994; Waste 1996). These habitats also support two-thirds of U.S. recreational fishing, which generated approximately \$13.5 billion that year (NMFS 1995). In addition, aquaculture of marine species in coastal waters is expanding rapidly and totalled \$242 million in 1992 (U.S. Department of Commerce 1994), and LMRs contribute significantly to the subsistence of many individuals and families. The potential contribution of LMRs in the future is even greater as overfished stocks are rebuilt, habitats restored, and threatened and endangered species recover.

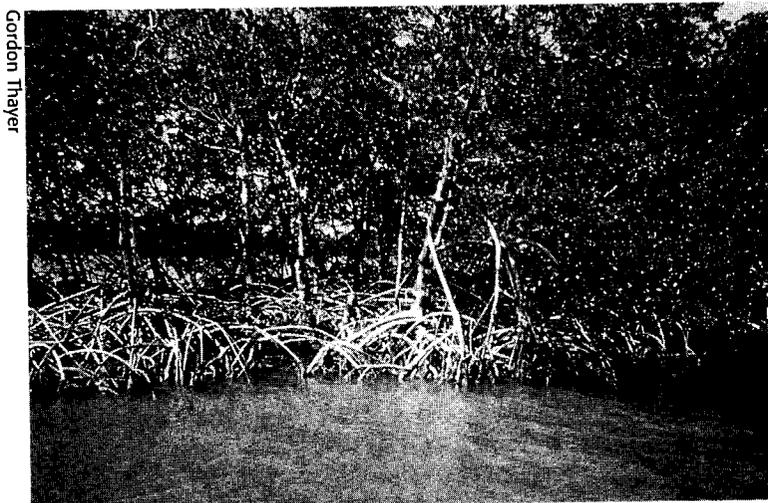
Habitat loss from pollution and development threatens the future viability of fisheries in the United States (Burns 1991; Brouha 1993) and poses a major national challenge. As human populations in coastal regions grow, LMRs are exposed to increasing pressure from toxic contaminants, excess nutrients, altered freshwater flow, and loss of habitat structure and biological diversity (Thomas 1995). Toxic compounds in agricultural runoff and industrial effluents contaminate habitats and cause pathologies in fish and shellfish. Excess nutrients in runoff cause eutrophication, and turbidity from erosion and development suppresses production of phytoplankton and submerged vegetation. Even boating can result in long-lasting damage to critical habitats as a result of propeller scour in submerged aquatic vegetation (Sargent et al. 1995) and anchoring on coral reefs. Alteration of freshwater flow regimes by withdrawals, diversions, or poor land-use practices reduces or degrades riverine habitat and increases salt intrusions into estuaries (Thayer 1992).

The continental United States has lost half of its original wetlands by water diversions, draining, and filling (Frayser et

al. 1983; Dahl and Johnson 1991; Tiner 1991). Habitat loss and degradation, along with overharvesting and climate change, are the principal causes for declining resources (e.g., J. Boreman, NOAA Cooperative Marine Education and Research Program, University of Massachusetts-Amherst, personal communication). Because pre-recruitment stages (eggs, larvae, and juveniles) and estuarine-derived forage species are dependent on the coastal zone, both nearshore and resident offshore species can be harmed by degraded shallow coastal and estuarine habitats (Hoss and Thayer 1993). Population declines include marine and aquatic mammals (e.g., Gulf of California harbor porpoise and manatee), turtles (e.g., loggerhead, Kemp's ridley and green), anadromous fish (e.g., salmon, striped bass, sturgeon, river herring, and American shad), and estuarine shellfish (e.g., oysters). While these declines are due to a combination of effects, clearly the impact of habitat degradation is greatest in the coastal regions where dramatic increases in human population and attendant activities have and are occurring. As indicated by Thomas (1995), it is likely that many of the changes in upland land use and cover have initiated or exacerbated estuarine and coastal habitat degradation. More than half of the U. S. population lives within 50 miles of the coast, and coastal communities have the highest rates of growth in the nation (U.S. Department of Commerce 1991). Current projections for U.S. population in the coastal zone suggest that even greater destruction of critical habitat and LMRs is likely to occur as competition for limited space and resources increases.

## The Approach

To protect, conserve, and restore aquatic habitats, the NMFS has developed a Habitat Research Plan (HRP) that will systematically guide its research on ecosystem function and linkages to improve scientific understanding and decision-making capability. The plan emphasizes collecting and synthesizing information that will increase the agency's ability to develop and implement management policies. To fully implement the plan requires (1) a more complete description of the structural and functional aspects of ecosystems;



Research on the functional value of red mangrove areas demonstrates that the prop root habitat provides important structure for fishery organisms. These habitat types frequently are subjects of permit requests for development.

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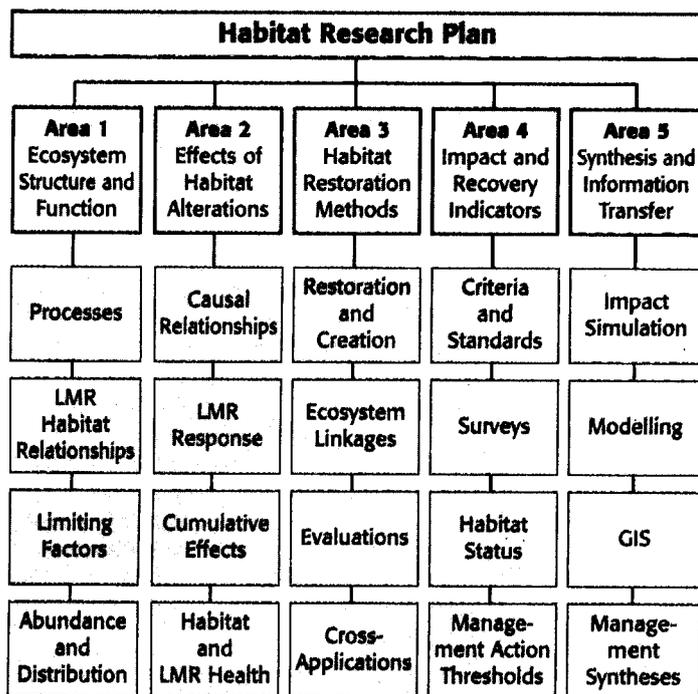


Figure 1 shows the five focal areas and associated elements of the NMFS National Habitat Program Research Plan.

(2) a more integrative approach to understanding the relationship among natural, affected, restored, or created habitats and LMRs; and (3) greater knowledge of the responses of habitats and LMRs to natural and anthropogenic impacts.

The Habitat Research Plan provides an overarching framework that combines basic and applied research with information syntheses on which to base landscape-level habitat management decisions. The concept of landscape ecology includes consideration of fluxes of organisms, materials, and energy within the spatial heterogeneity of the surrounding area (Pickett and Cadenasso 1995). As pointed out by Pickett and Cadenasso (1995:334), "the spatial heterogeneity in ecological systems at various scales often influences important functions, ranging from population structure through composition to ecosystem processes...." To ensure that the HRP is broad-based and is responsive to national and regional issues, the plan includes recommendations from NMFS scientists and managers as well as from other federal and state agencies and private industries given during a series of NMFS-sponsored habitat workshops held in 1995.

The HRP outlines a systematic approach in five areas (Fig. 1) and provides both a coordinated research program based on basic ecological research and an agenda of applied research responsive to changing management needs. Syntheses of research findings and information transfer are key elements of this plan. NMFS research program staff will work closely with other NOAA programs, including the Office of Ocean and Coastal Resource Management, Coastal Ocean Program, Coastal Services Center (Charleston, South Carolina), and National Sea Grant Program, to meet NOAA's goals, particularly regarding the NOAA strategic plan element on healthy coastal ecosystems (NOAA 1995). The NMFS will work closely with other federal agencies to increase cooperation and partnerships, maximize research information,

and reduce potential duplication of research efforts. Funds for this research program will come from a combination of base funds and extramural support.

## Research Areas

### Area (1): Ecosystem Structure and Function

Understanding the structure and function of natural ecosystems, their linkages to one another, and the role they play in supporting and sustaining LMRs (e.g., their abundance, distribution, and health) is critical. Knowing when and how systems are affected, assessing the cause and degree of impact, and providing the basis for restoring and maintaining these systems are integral to this research area and must be evaluated in terms of landscape ecology. Research on ecosystem structure and function will provide the necessary foundation for linking all areas of the HRP (Fig. 1) and will provide the basis for making fundamentally sound management decisions. Thus, assessing habitat impacts, developing restoration methods, evaluating restoration effectiveness, developing indicators of impact and recovery, and synthesizing and transferring information for the development of management policy and regulations all are dependent on a comprehensive understanding of ecosystem structure and functioning.

Research in this area will include studies on the relationship between habitat and yield of LMRs, including seasonality and annual variabilities and the influence of chemical and physical fluxes on these relationships. These research efforts will depend on knowledge of basic life histories as well as habitat structural integrity and limiting factors, and must be evaluated within the context of habitat mosaics or habitat heterogeneity. Therefore, data on habitat location are integral to this research area. Information generated in this research area provides a foundation on which to predict responses of organisms and habitats to perturbations and trajectories of recovery or success of restoration.

### Area (2): Effects of Habitat Alterations

Knowledge of the causes of observed harm to ecosystems is critical to restoring past losses and preventing future degradation and loss of habitats essential for maintaining and enhancing LMRs. Therefore, quantifying the responses of habitats and LMRs to natural and anthropogenic alterations is not only a prerequisite to determining the degree of impact, predicting recovery rates, and recommending the most effective restoration procedures but also is a requisite to establishing effective protective measures.

The basis for determining causal relationships depends on an understanding of the natural structure and function of an ecosystem and individual LMR requirements and population characteristics. While the NMFS is primarily interested in maintaining and restoring LMR populations, relating impacts observed at the individual level to effects at the population level has proven difficult. Thus, there is a need to specifically link habitat impacts to LMR populations.

Studies emphasized will include cause-and-effect research designed to evaluate responses of LMRs and habitats to physical and chemical modifications of coastal and estuarine systems. The NMFS will encourage research that considers downstream responses to upland modification and the role of buffer zones as well as LMR and habitat responses to physical and waterflow alterations and water quality modifications.

Because information will be generated from responses to both individual and cumulative impacts, these studies will provide the basis for guidelines and regulations to protect habitats and develop remedial cleanup standards. These cause-and-effect databases will furnish information pertinent not only to permit-related activities but also to NMFS-mandated responsibilities in restoration planning and implementation.

### *Area (3): Habitat Restoration Methods*

While methods for restoring certain habitats (e.g., salt marshes and seagrass meadows) exist, most have not been rigorously tested under experimental conditions throughout wide geographic areas and at different scales (see Kusler and Kentula 1989; Cairns 1990; Thayer 1992). Additionally, for other habitats (e.g., coral reefs, intertidal and subtidal substrates, riparian habitat) only limited methodology exists, and little emphasis has been placed on rapidly restoring biodiversity and monitoring for success and persistence. Consequently, scientists have viewed a significant proportion of restoration actions with skepticism regarding their success and rates of habitat recovery or development. Current methods to clean up, restore, or create productive LMR habitats must be improved, and new, innovative techniques must be developed and evaluated using statistically rigorous approaches.

Research topics and areas of concern include analyzing the success of contaminant sequestration; assessing bioremediation techniques; developing and evaluating new habitat restoration techniques; experimenting on transplant species culture techniques; and evaluating the role and size of buffers and the importance of habitat heterogeneity in the restoration process. Research on restoration will lead to scientific information on trajectories of recovery and stability of created and restored systems, including physical, chemical, and biological components and processes. Assessing new techniques and evaluating current techniques throughout geographic regions and scales will provide foundations for evaluating success. Most importantly, this research will generate guidelines for improving best management practices and restoration plans.

### *Area (4): Indicators of Habitat and LMR Impacts and Recovery*

Increasing and extensive exploitation of coastal resources demands that indicators be used to simplify the process of determining whether an ecosystem, habitat, or LMR is affected or is recovering. Developing indicators of impacts and recovery is critical for managers judging the "health" status of a habitat or LMR and the need for corrective actions. Such development must be based on information from comparative research on the structure and function of disturbed, natural, and/or restored habitats. Ideally, habitats of different ages and geographical locations should be evaluated for a suite of biological, chemical, and physical parameters. Time-dependent biotic population analyses and contaminant-level follow-up evaluations for sediment, biota, and water will be encouraged. This type of research will help managers identify the habitat status or "health"; standardize indicators for specific habitats through comparisons across geographic gradients and scales; and develop recommendations on the temporal efficacy of chemical cleanup techniques and most appropriate measures to assess success. The NMFS will use such guideposts to develop and improve best management practice approaches.

### *Area (5): Synthesis and Information Transfer*

The synthesis and timely transfer of information derived from research findings and existing literature are key elements of NMFS's National Habitat Program and this HRP. Decisions on permitting, regulation, enforcement, redirection of research efforts, and development and implementation of restoration plans must be made with the best available information. Scientists must step back from their research long enough to provide timely information syntheses to habitat managers. Likewise, NMFS habitat managers must recognize that generic information generated by the scientific community does have powerful application to their site-specific problems.

Technology and information transfer will be expedited through the use of all available information sources and the application of user-friendly information bases. Geographic information systems provide the opportunity to amass large quantities of complex data, thereby providing potential for decision makers to make relational observations; such use is strongly encouraged. Many areas of synthesis and transfer have been indicated in our presentations of the earlier four research areas and will not be repeated here. Other examples include information syntheses of critical fishery habitats and modes of protection and restoration; development and testing of economic valuation approaches for ecological systems; and landscape approaches to basinwide management, including permitting and restoration. Such collations of current and evolving information bases are important to fishery management councils and those charged with protecting and recovering certain species as well as to habitat managers concerned about developing and implementing policy. These syntheses could be done within the NMFS, through partnerships with other agencies, and by contract. However, it is important that syntheses be provided in a useable format and even published in outlets available to both scientific and management communities. The scientific community must participate in the synthesis and transfer process.

## **Implementation**

The HRP is divided into five interlinked areas and several elements (Fig. 1) that provide a framework for the type of research and continuity needed to effectively manage LMR habitat. In some instances this linkage between research areas may be hierarchical. As we discussed earlier, research on ecosystem structure and function (Area 1)



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Sampling of salt marsh habitats using gear such as fyke nets, shown above, provides information on the resource value of these habitats for managers.

provides the foundation for linking all areas. For example, knowledge of the structure and function of the ecosystem must be known before managers can determine the effects of habitat alterations (Area 2), develop restoration methods (Area 3), or develop indicators of impact and recovery (Area 4). There are feedbacks among these areas. As noted by Root and Schneider (1995:337), research “across scales of the interactions within and between the biotic and abiotic effects of disturbances are...required for system-level understanding and impact assessments.” Elements shown for each research area in Fig. 1 may vary by region, but they depict the stages and continuity of information required to develop a comprehensive database on which to base important resource decisions. Research founded on this approach will provide the NMFS with a broad information base that is scientifically and ecologically credible, national in scope, and responsive to management needs.

The NMFS has not had a definitive habitat research guidance document under which to organize its habitat research activities and to develop mutually beneficial partnerships with state and other federal habitat management entities. However, the agency has funded habitat research. During the 1995 fiscal year the NMFS budget for habitat research was \$7.9 million (FY 1995 Appropriations); funding requested for FY 1996 was \$8.4 million (FY 1996 Conference Report level), and funding requested for FY 1997 is \$11.9 million (President Clinton’s FY 1997 budget request). The habitat research projects carried out have and continue to address management information needs, and researchers have received national and international recognition. A goal of the NMFS, in addition to increased partnerships with federal and state agencies and academia, is to at least double the habitat research funding requested for FY 1997 during the next five years.

The HRP will help organize ongoing and future habitat research within the agency, identify research gaps relative to management needs, and organize budget initiatives and partnerships to address habitat issues. These issues are increasing, not decreasing, as the coasts continue to develop, and habitat issues are receiving national attention from the press, recreational and commercial fishing communities, and general public. By the end of 1996, ongoing and newly proposed habitat research within the agency will be collated by the NMFS Habitat Conservation Office based on the five focal areas of the HRP. As we noted, aspects of the research plan already are underway, and a synthesis will be available this year. Specific new research activities and directions will be implemented in stages as new funding initiatives occur, but the goal is to have integrated programs within and across the focal areas. As noted by Waste (1996:29) for the NMFS National Habitat Program (of which this Habitat Research Plan is a part), “many factors beyond the control of NMFS will influence program implementation: budget constraints, personnel limitations, and redirections in policy by the Clinton administration or Congress. Nevertheless, the new NMFS National Habitat Program (and likewise this Habitat Research Plan) is striving to focus staff, budget, and priorities to make the greatest positive difference in sustaining living marine resources and their habitats.” A holistic and integrated research effort is critical to this achievement and will produce information that can be used to address needs of fisheries, protected resources, and their habitats. 

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