RESTORING COASTAL HABITATS

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Coastal habitat restoration encompasses the range of remedies that society undertakes to heal injuries to the coastal environment. Throughout the United States, public and private institutions are working to develop and apply new approaches to coastal restoration. A number of Federal agencies, guided by a suite of legislation, have programs aimed at improving the environmental quality of the Nation's coasts.

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National Oceanic and Atmospheric Administration (NOAA). 1998 (on-line). "Restoring Coastal Habitats" by Tom Ardito and Darlene Finch. NOAA's State of the Coast Report. Silver Spring, MD: NOAA.

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INTRODUCTION

Coastal habitat restoration encompasses the range of remedies that society undertakes to repair, reinvigorate, or replace parts of the coastal environment that have been lost or injured as a result of human activities or natural events. Restoration projects as diverse as planting salt marshes and repairing coral reefs have involved ecologists and schoolchildren, lawyers and crane operators, fishermen, divers, and engineers. This emerging discipline cannot solve all the problems confronting the nation's coasts, nor can it obviate the need for stewardship, conservation and pollution control. Coastal habitat restoration can provide an effective means of redressing human impacts on the coastal environment, however, and the completion of each new restoration project improves the Nation's capability to repair the damage inflicted on the coast by a technological society.

Photo 1. Volunteers work to restore an urban marsh in Commencement Bay, Washington.

The term *habitat restoration* refers to site-specific actions designed to improve the biological productivity or functioning of a particular ecosystem or area. Habitat restoration takes a variety of forms, depending on the project's purpose, its legal context, site characteristics, and other factors. Often, habitat restoration seeks to return an area to a *baseline condition*– for example, a particular vegetative community–that existed prior to an injurious incident such as an oil spill. In other cases, restoration seeks to improve the biological value of an area to compensate for a specific loss elsewhere–an approach to restoration known as *mitigation.* A third approach is *habitat creation,* the establishment of a habitat type in a location where it did not previously exist. The development of ponds to provide breeding habitat for waterfowl is an example of habitat creation common to many National Wildlife Refuges.

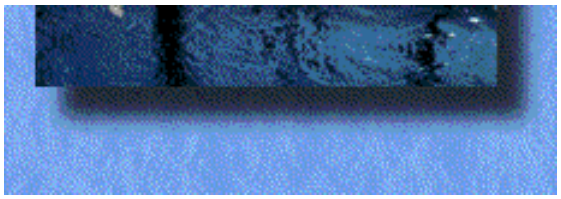

Photo 2. Newly planted mangrove seedlings wear protective tubes to shield them from wave action.

Photo 3. Oil well accidents, such as this one in coastal Louisiana, are one cause of oil spills.

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NATIONAL PICTURE

Overview

In the past decade, the science, practice, and policy of coastal habitat restoration have advanced significantly. Habitat restoration is now being undertaken all along the Nation's coasts, on all kinds of shorelines, in response to a wide variety of impacts and threats. Nevertheless, no single organization or entity has oversight over coastal habitat restoration throughout the United States, however. Private citizens, universities, nongovernmental organizations, and government groups at every level are all working to restore coastal habitats.

At the national level, no fewer than 14 Federal programs within five cabinet-level departments are working to restore coastal habitats, while at least 11 Federal laws authorize and fund restoration activities. Some of the most significant Federal agencies, programs, and legislation involved in coastal habitat restoration are described below.
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Agencies and Programs

U.S. Department of the Interior (DOI). Within DOI, a number of programs work on coastal habitat restoration, several of which are directed at the national policy goal of "no net loss of wetlands." The U.S. Fish and Wildlife Service, for example, has a Coastal Habitat Conservation Program that includes:

- *The Coastal Ecosystems Program,* which identifies resource problems and carries out conservation projects in 11 high-priority coastal areas. In a two-year time period, the program restored more than 10,000 acres and protected an additional 30,000 acres of coastal habitats.
- *The National Coastal Wetlands Conservation Grants Program,* which provides competitive grants for coastal states to acquire, restore, or enhance coastal wetlands and tidelands.

Photo 4. Wetlands are the focus of many of the U.S. Department of the Interior's coastal habitat restoration efforts.

Other entities within DOI that undertake restoration are the National Park Service (NPS) and the Bureau of Land Management (BLM). NPS restores habitats in the national parks, while BLM works to improve the productivity of wetlands and to restore riparian habitats on nonpark, nonmilitary Federal lands.

National Oceanic and Atmospheric Administration (NOAA). NOAA has several programs that undertake coastal habitat restoration. Through the National Habitat Plan (NOAA, 1996a), NOAA's National Marine Fisheries Service provides a framework for conservation and restoration of coastal habitat, with emphasis on habitats of importance to marine fish. NOAA's Damage Assessment and Restoration Program (NOAA, 1995) oversees the restoration of coastal resources injured by oil spills and hazardous releases; funding for the restoration work comes from the oil carrier, industrial polluter, or other party responsible for the injury. The Office of Ocean and Coastal Resource Management supports coastal habitat restoration through state coastal management grants, while the National Estuarine Research Reserves System funds site-specific restoration activities. NOAA's National Marine Sanctuary Program restores injured natural resources –like coral reefs–within the Nation's marine sanctuaries.

Photo 5. Volunteers, like this scuba diver, participate in seagrass restoration efforts.

U.S. Department of Agriculture (USDA). The coastal habitat restoration programs of the USDA focus primarily on wetlands. The Natural Resource

Conservation Service (NRCS) assists private landowners with land and water conservation, while the Water Bank Program works with Federal agencies to preserve and restore habitats for migratory waterfowl. In addition, NRCS administers the Wetlands Reserve Program, which purchases conservation easements from landowners to restore, enhance, or create wetlands. These programs have dramatically reduced wetlands loss due to agriculture. The U.S. Forest Service within USDA undertakes restoration activities in response to destructive logging practices in the national forests.

U.S. Department of Defense (DOD). The U.S. Army Corps of Engineers has principal responsibility for regulating and maintaining the Nation's waterways. In addition, the Corps designs, constructs, and maintains flood control and other water resource development projects. It undertakes coastal habitat restoration under a variety of laws and programs, largely to mitigate for dredging or other coastal development, or to correct environmental damage caused by flood control projects. DOD also manages the Defense Environmental Restoration Program, which is responsible for cleaning up and restoring environmental damage at the Nation's military installations.

Photo 6. Many restoration projects are aimed at preserving and restoring wetlands for migratory birds and other estuarine creatures.

U.S. Environmental Protection Agency (EPA). EPA's National Estuary Program (NEP) and Great Waters Program promote coastal habitat restoration in conjunction with efforts to protect nationally significant water bodies. Through the NEP process, local, state, and Federal representatives work together to develop consensus-based plans for estuarine protection and restoration. At present, there are 28 estuaries within the NEP, while the Great Waters Program addresses larger coastal systems: the Gulf of Maine, Chesapeake Bay, the Gulf of Mexico, and the Great Lakes (USEPA, 1992).

Coastal America: A collaboration of 10 Federal agencies and nonfederal partners, Coastal America promotes coastal restoration projects around the U.S. In 1991-1994, Coastal America participated in more than 140 projects, with total funding of about $40 million, helping to protect the habitat of at least 20 endangered species, restore over 100,000 acres of wetlands, and reestablish hundreds of miles of spawning habitat for anadromous fish such as salmon, shad, and herring (Coastal America, 1995, 1996).
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Legislation

Federal Water Pollution Control Act (Clean Water Act) of 1972. The goal of the Clean Water Act is to "restore and maintain the chemical, physical,

and biological integrity of the Nation's waters." The Clean Water Act regulates the discharge of pollutants from industry and other sources; works to upgrade sewage treatment facilities through grants to the states; and requires states to monitor and report on the quality of coastal waters. Section 404 of the Act regulates the dredging and filling of waters or wetlands, and authorizes the practice of wetlands banking and mitigation –restoration that seeks to compensate for wetland impacts at one location by enhancing or creating a wetland at another site.

Photo 7. Coastal development, like this housing project, destroys estuarine habitats.

Coastal Zone Management Act (CZMA) of 1972. The purpose of CZMA is to "preserve, protect, develop, and where possible, to restore or enhance the resources of the Nation's coastal zone." The Act establishes a partnership between the Federal government and coastal states to accomplish this goal. States can use Federal matching grants authorized by CZMA for habitat restoration or for Special Area Management Plans (SAMPs), which often identify restoration needs for specific coastal ecosystems. In addition, the statute establishes the National Estuarine Research Reserves System, mentioned earlier, which sets aside ecologically valuable coastal areas for preservation and research.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) of 1980 and 1986 and Oil Pollution Act (OPA) of 1990. Together, CERCLA and OPA establish a mechanism for cleaning up oil spills and discharges of hazardous materials, and for restoring natural resources injured by such incidents. These laws require the Federal government to act as trustee, or caretaker, on behalf of the public to ensure that injured resources are fully restored. Under CERCLA and OPA, the polluter responsible for an injury is liable for the cost of response, cleanup, and restoration.

Photo 8. "Mitigation" is a form of habitat restoration often used to compensate for the environmental impacts of port development.

Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) of 1990. Through CWPPRA, states can obtain matching Federal grants to protect, restore, conserve and enhance threatened coastal wetlands. The Act establishes a multi-agency task force to administer the program in Louisiana, the state with the greatest coastal wetland losses. Since 1993, CWPPRA has provided $40 million in funding for projects to restore nearly 50,000 acres of Louisiana's coastal wetlands.

Magnuson-Stevens Fishery Conservation and Management Act of 1996. The Magnuson-Stevens Act requires regional fishery management councils to describe and identify habitats essential to the species they manage, and to outline measures to conserve and enhance such habitat. The Act requires the National Marine Fisheries Service to review Federal and state projects for potential adverse impacts on essential fish habitats, and, among other things, to recommend measures–such as habitat restoration–for mitigating adverse impacts caused by such projects.

Other Federal laws that authorize and fund coastal habitat restoration include:

- *National Marine Sanctuaries Act*
- *Water Resources Development Act*
- *North American Wetlands Conservation Act*
- *Food, Agriculture, Conservation and Trade Act*
- *Rivers and Harbors Act.*

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Where Do We Go From Here?

As the foregoing sections illustrate, a number of Federal programs are working to restore coastal habitats around the United States. Each statute or program has a particular focus–in some cases, a specific type of habitat, like wetlands; in others, a specific impact, like oil spills or logging. This array of efforts has launched many successful projects, restoring a variety of coastal habitats. The diversity of funding sources and legal authority, however, has led to a somewhat piecemeal approach to restoration, particularly when one looks beyond a single habitat type toward the interaction among the habitats that make up the ecosystem of an estuary, watershed or coastal region.

Photo 9. Restoration of the environment is a developing science; research will help identify optimal approaches.

Impacts on the coastal environment will increase over the coming decades as Americans continue toward the shore, using the coastal environment more intensively than ever. To maintain abundant fish and wildlife, clean water, and healthy coastal ecosystems, we should plan habitat restoration at watershed or regional scales and integrate activities from different programs or statutes. Research on restoration should continue, so we can better measure the success or failure of restoration efforts. We must apply the science and practice of restoration ever more broadly, in order to keep pace with human impacts and maintain the quality of the coastal environment.
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REGIONAL CONTRASTS

America's coastline is wondrously diverse–geographically, biologically and culturally. As a result, coastal restoration along the high- energy coasts of the Northeast and Northwest is very different from restoration in the broad estuarine and wetland areas of the Mid-Atlantic, Southeast, and Gulf of Mexico.

Northeast and Northwest

The Northeast and Northwest are temperate, high-energy coasts, where rocky headlands are punctuated by small, well-mixed estuaries. The salt marshes that border estuarine shorelines in the Northeast and Northwest are small by comparison with their southern counterparts.

Northeastern estuaries lie in the most densely populated and highly industrialized areas along the Nation's coasts. The legacy of their intensive use is a century or more of shoreline modification, resulting in the loss and degradation of coastal wetlands. Homes and factories discharge a variety of pollutants into estuarine waters, from household sewage to chlorinated organic compounds like PCBs (polychlorinated biphenyls). In addition, the use of petroleum products for heating and transportation leads to periodic oil spills, particularly at Northeastern port facilities like New York Harbor.

Photo 10. One focus of restoration in the populous Northeast is on wetlands degraded by the intensive use of coastal areas over the last century.

Restoration efforts in the Northeast and Northwest seek to redress these impacts, focusing on estuarine habitat. Projects in New Bedford Harbor,

Massachusetts and Commencement Bay, Washington are working to rectify injury to estuarine ecosystems caused by the industrial discharge of toxic compounds. In New York Harbor, volunteers work with municipal governments to replant salt marshes denuded by an oil spill. Similarly, all along the Northeast and Northwest coasts, people are working to restore coastal wetlands by improving tidal exchange where the construction of roads, railbeds, or dikes has altered wetland hydrology.
(top)

Mid-Atlantic, Southeast, and Gulf of Mexico

Compared to the rugged coasts of the Northeast and Northwest, the Mid-Atlantic, Southeast and Gulf coastlines are dominated by large estuarine systems and vast wetlands. Driven by rising sea level and 20th century flood control projects, wetland loss is occurring on a grand scale here, so an ambitious approach to restoration is essential.

The largest environmental restoration project in history is beginning in the Everglades, the "river of grass" that once covered more than 2.5 million acres of South Florida. A century of human modification of the Everglades has controlled flooding, created some of the richest and most productive farmland in the U.S., and provided housing and recreation areas for millions of Americans. Changes in hydrology and land use have transformed the Everglades and nearby coastal ecosystems, however, causing drastic declines in the numbers of wading birds, destroying fisheries, and threatening the survival of species such as the Florida panther. To reverse the damage, the Kissimmee River and other waterways that have been channelized for decades will be re-engineered to restore historical flooding patterns, an effort that will cost $3 billion to $5 billion over the next 10 to 15 years. A task force of state, Federal and tribal partners has been established to plan and implement restoration projects. Several are already under way.

Photo 11. Restoration in Louisiana, with 40% of the nation's coastal wetlands, is on a large scale.

Flood control efforts have resulted in a loss of coastal wetland habitat on the Gulf of Mexico as well. Louisiana is home to 40% of the Nation's coastal wetlands, from old-growth cypress swamps to salt marshes formed by the deposition of river sediments where the Mississippi River meets the sea. The construction of dams, levees, and canals to control flooding and improve navigation has deprived the Mississippi River Delta of marsh-nourishing sediment loads, leading to increased rates of coastal erosion – roughly 30 square miles per year. In response, restoration efforts in Louisiana focus on large-scale wetlands creation and enhancement projects, such as the Point au Fer project described in the case studies section (Boesch et al., 1994).

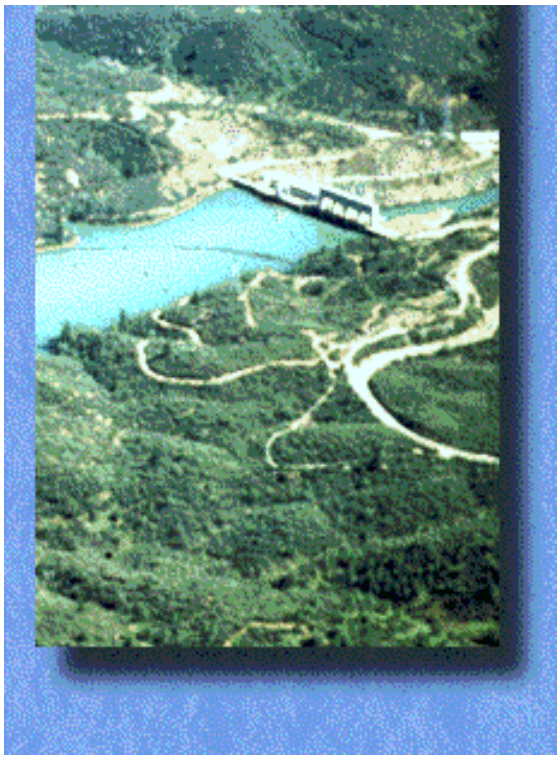

Photo 12. Some restoration in the Northwest attempts to counter the negative effects of dams, which have caused a dramatic decline in many salmon runs.

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Keystone Species as the Focus of Restoration

In addition to differences in geography and natural resources, differences in biological factors affect regional approaches to coastal habitat restoration. Each of the Nation's coastal ecosystems is home to a unique set of plants and animals. Restoration is often directed at "keystone species" – organisms whose abundance is essential to the survival of a particular biological community. Restoration of a keystone species that has declined due to human exploitation, habitat destruction, or other factors can benefit a number of species–indeed, in some cases, an entire ecosystem.

In the Mid-Atlantic and Gulf of Mexico, oysters are a keystone species. Yet on the Chesapeake Bay, a century of intensive harvesting has reduced this once-plentiful shellfish to about 1% of its historical abundance. The fishery has collapsed, and research indicates that the decline of the oyster population is partly responsible for a systemwide deterioration of the environmental quality of the Bay (Newell, 1988). In response, citizens' groups, the Federal government, the states of Virginia and Maryland, and universities have initiated efforts to restore oyster beds throughout the Chesapeake Bay (Chesapeake Bay Program, 1993).

A keystone "species" in the Northwest and Alaska is the Pacific salmon; it is not, in fact, a single species, but a variety of distinct species and populations or "runs" throughout the region. The Columbia River alone supported salmon runs estimated at 15 million fish per year for about the past 8,000 years. Beginning in the 1930s, however, the construction of dams for hydropower, irrigation, and navigation has prevented salmon from reaching their spawning habitat, spurring a precipitous decline to about 2% of historical abundance. Coastal habitat restoration in the Northwest, therefore, is largely directed toward salmon habitat. Programs range from community efforts to revegetate and stabilize eroding streambanks, to the construction of multimillion-dollar fish passageways to allow salmon to return to historical spawning habitat.

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CASE STUDIES

Northeast: *World Prodigy* Oil Spill Restoration, Narragansett Bay, Rhode Island

On June 23, 1989, the oil tanker *World Prodigy* ran aground off of Newport, RI spilling more than a quarter of a million gallons of home heating oil. The oil spread over 120 square miles, killing marine life and closing beaches and fishing grounds throughout Narragansett Bay. It poisoned eggs and larvae of fish and shellfish as they floated at the surface. The Federal government negotiated a $600,000 settlement with the ship's owners exclusively for use in restoring natural resources harmed by the spill (NOAA, 1996b).

Photo 13. Fishermen volunteered to transplant quahogs in Narragansett Bay as part of an oil spill restoration project.

Four restoration projects are under way in Narragansett Bay. One project involves transplanting eelgrass to help reestablish this vital habitat for fish and shellfish at several locations in the Bay. Another project is creating cobblestone lobster reefs as protective habitat for young and adult lobsters. A third created "spawning areas" for the reproduction of transplanted hard clams, known locally as quahogs. In the fourth project, the tidal exchange of seawater is being restored to improve the ecological value of a marsh at the Sachuest Point National Wildlife Refuge in Middletown, Rhode Island.
(top)

Southeast: *Maitland/Elpis* Coral Reef Restoration

In the autumn of 1989, two large commercial vessels–the M/V *Alec Owen Maitland* and the M/V *Elpis*– ran aground on coral reefs within the

Florida Keys National Marine Sanctuary. The groundings and subsequent attempts to free the ships resulted in significant injury to the reefs as well as to the corals living there. The large craters created in the reef surface were in danger of widening as a result of erosion. The substantial pieces of rubble left behind were free to shift during storms, posing additional hazards to nearby coral reefs.

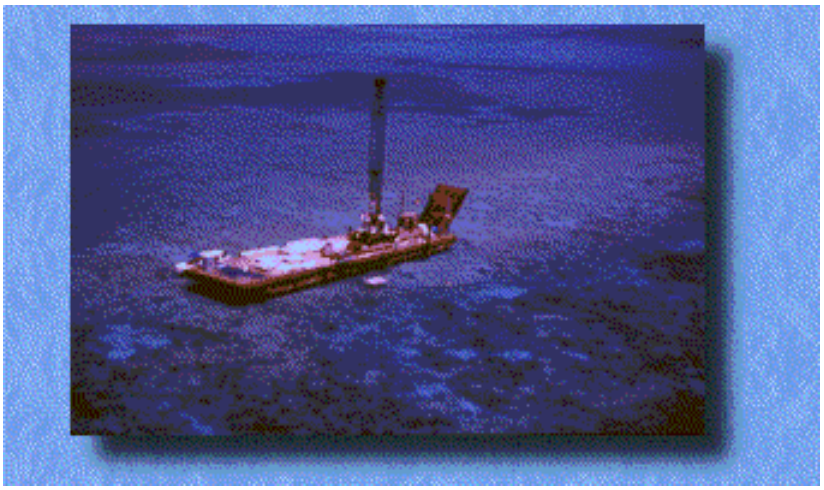

Photo 14. A work barge replaces damaged sections of coral reef with specially constructed replacement sections.

A team of government agencies and private contractors led by NOAA planned and implemented the restoration of the damaged reefs (Bodge, 1996). Goals of the plan included:

- Stabilizing the seabed and preventing additional injury at the grounding sites;
- Recreating stable reef substrate similar to adjacent, undisturbed reef areas;
- Enhancing biological recovery and recolonization through transplants of corals, sea fans, and sponges; and
- Monitoring the structural and biological restorations for an extended period.

Physical restoration at the *Maitland* grounding site entailed fabricating a series of "reef modules"–10-ton concrete slabs with upper surfaces textured to resemble those of living reefs–and placing them into the crater left by the vessel. At the *Elpis* site, limestone boulders from a Florida quarry were used to repair the damage. Corals and other reef organisms have begun to recolonize the restoration sites; transplantation efforts by Sanctuary biologists will accelerate biological recovery.
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Gulf of Mexico: Point au Fer Wetland Restoration

The Point au Fer Hydrologic Restoration Project is a large-scale wetland restoration in Terrebonne Parish, Louisiana. Undertaken under the CWPPRA, the project focuses on two areas, each with a slightly different purpose. Area 1 consists of saline and brackish marshes on the southeastern side of Point au Fer Island, while Area 2 is a brackish marsh on the southwestern side of the Island (USACOE, 1997).

Photo 15. Project managers stabilized this narrow beach with boulders to prevent erosion of the wetlands behind it.

The purpose of the project in Area 1 is to restore the natural marsh hydrology altered by canals dug for oil and gas development. Seven "plugs" of oyster shell have been constructed in the canals, restoring historical water flows across the island and returning the marshes to their original brackish condition.

In Area 2, the project addresses threats posed to Point au Fer Island by another oil and gas development canal. The canal was dug parallel to shore, separated from the Gulf of Mexico by a narrow beach. The beach was subject to overwash during storms and was in danger of breaching, which would accelerate wetland loss and alter the brackish-water marsh system. The Point au Fer project team placed "rip-rap" (boulders) along a 4,000-foot stretch of shoreline, slowing erosion and preventing the Gulf of Mexico from breaching the beach. The project will directly protect 350 acres of wetlands and ecologically enhance another 3,500 acres.
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EXPERT INTERPRETATION

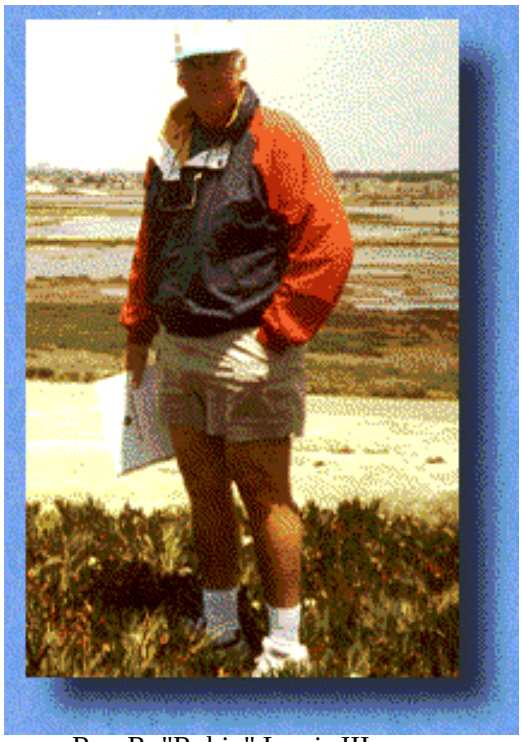
The four individuals below are experts in the topic of Restoring Coastal Habitat. Here they voice their opinions on two questions relevant to that topic.

Question 1 – How effective is habitat restoration in addressing human impacts on the coastal environment?

Question 2 – What developments are most necessary before coastal habitat restoration can adequately address the range of human impacts on the coast?

Experts

			
Roy R. "Robin" Lewis	Charles H. Peterson	Fred Short	Joy B. Zedler



Roy R. "Robin" Lewis III

President, Lewis Environmental Services, Inc., Tampa, Florida

Roy R. "Robin" Lewis is a professional wetland scientist and certified as a senior ecologist by the Ecological Society of America. He has been involved in coastal habitat restoration for 30 years in Florida, California, Central America and the Caribbean. He has published more than 50 papers on this and related topics and is the editor of *Creation and Restoration of Coastal Plant Communities* .

Response to Question 1

Response to Question 2

Question 1. How effective is habitat restoration in addressing human impacts on the coastal environment?

Click here for audio response

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Coastal habitat restoration, properly designed and constructed, is very effective in reestablishing certain habitat types like tidal marshes and mangrove forests. In addition, these restored habitats have been scientifically documented to reestablish functional, high-quality coastal fish communities within three to five years, and attract and support healthy populations of fish-feeding birds like herons and egrets. Other functional characteristics of these restored habitats such as populations of less mobile sea creatures like polycheate worms and clams take at least twice as long to approach normal levels.

Coral and seagrass habitats are more difficult to establish successfully, and many coastal habitat restoration projects of all types either are only marginally successful, or completely fail to accomplish project goals. Often these failures are due to inexperienced individuals attempting to design and build projects without adequate training. Even agency reviewers often know much less than the minimum needed to raise a red flag when a set of flawed design drawings crosses their desks.

Good intentions are not enough to justify wasting millions in limited resource restoration dollars on a bad project located in the wrong place and orphaned early by inadequate maintenance and long-term protection. We can do better, and we must do better to effectively utilize modern restoration technologies to revitalize our coasts.
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Question 2. What developments are most necessary before coastal habitat restoration can adequately address the range of human impacts on the coast?

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Modern coastal habitat restoration technology, derived from almost five decades of experimental success and failure, depends heavily upon hands-on work by ecologists attempting to repair human-caused damage to marshes, reefs, mudflats and mangroves. This technology is not formally taught at any university or college, but is transmitted to a new generation of restoration ecologists largely by those brave scientists willing to admit that they do not have all the answers, and who often made mistakes before they learned by doing. This small cadre of experienced restorationists is attempting to institutionalize the teaching of restoration.

Unfortunately, habitat restoration is often confused with habitat mitigation. Restoration for the sake of putting back lost habitats, rather than getting a permit to destroy one habitat in exchange for making another, is clearly in the public interest and needs support from citizens, scientists and coastal managers. While artificial reefs and fish hatcheries have enjoyed widespread support in spite of the lack of scientific evidence that they really "work," habitat restoration is still considered by many to be "too experimental" or too expensive. An

example is the Florida Saltwater Fishing License fee program where $100 million has been raised in ten years, and less than $200,000 spent on coastal habitat restoration.

Routine mistakes in coastal habitat restoration design and construction are repeated because knowledge gathered by experienced professional restoration ecologists is often overridden by engineering considerations. Understanding how to move dirt and use concrete and steel do not automatically translate into understanding the hydrologic requirements of plants and animals.

We have the technology to do a better job. We CAN cost-effectively restore coastal habitats, but do we have the moral strength and honesty to acknowledge our current ill-chosen path that ignores the need for training and retraining, and to change direction in mid-stream?
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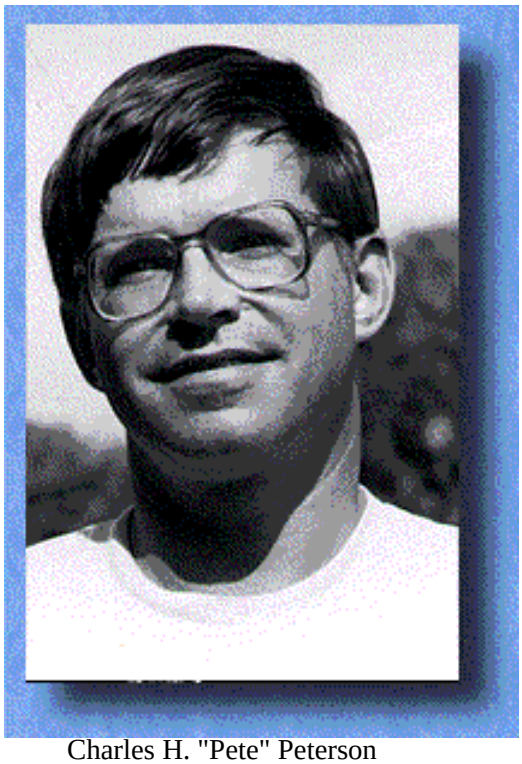

Charles H. "Pete" Peterson

Alumni Professor of Marine Science, Biology, and Ecology, Institute of Marine Sciences, University of North Carolina at Chapel Hill

Dr. Peterson has taught at the university level and has studied the ecology of seagrasses and the soft sediment habitats of mud and sand flats and sandy beaches for nearly 25 years. He has served on numerous scientific steering and advisory committees as well as on natural resource management bodies. Most recently, he has studied oyster reefs, the functions of temperate reef habitat, and the ways in which various habitats link together in the coastal environment.

Response to Question 1

Response to Question 2

Question 1. How effective is habitat restoration in addressing human impacts on the coastal environment?

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We have made substantial progress in coastal habitat restoration by applying this guiding principle: Recreate the structure and the functions shall come. This is not unreasonable but requires more testing. Restoring natural structure typically involves provision of biogenic habitat. The long-term stability of such restored habitat is still in doubt, and recovery of functions has proved slower in some habitats such as salt marshes than in others like seagrass meadows.

Some important habitats are not managed as such because of use conflicts, notably oyster reefs, the temperate equivalent of coral reefs. Oyster reefs are treated as a fishery resource not as habitat, and are degraded by mining for shellfish without adequate provision for their preservation or restoration. Habitats like mudflats and beaches that lack emergent biogenic structure are often ignored in restoration plans despite serving important ecosystem functions.
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Question 2. What developments are most necessary before coastal habitat restoration can adequately address the range of human impacts on the coast?

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The greatest challenge ahead in coastal habitat restoration is grappling with global warming and consequent sea level rise. Fortification of estuarine shorelines by bulkheads dooms the intertidal zone, including salt marshes. Protection of beach front development implies increasing degradation of ocean beach habitat by renourishment and bulldozing with inadequate attention to habitat value. More coral reef losses through bleaching, turbidity increases, and other climate-related changes are likely.

We must develop and apply protocols of holistic ecosystem management in the coastal zone to synthesize processes across the landscape of multiple habitats. We must analyze the roles of multiple stressors, such as especially eutrophication via processes across the watershed and via atmospheric deposition, the direct and indirect effects of fisheries, and the release of synthetic organic chemicals. Only then can coastal habitat restoration incorporate the complete web of important biotic and abiotic interactions that dictate its success or failure. Despite progress, coastal habitat restoration will never replace conservation and protection as the most reliable and least costly means of delivering valuable ecosystem services.
(top)

Fred Short

Associate Research Professor,
Department of Natural Resources
and Jackson Estuarine Laboratory,
University of New Hampshire

Dr. Short has been affiliated with the Jackson Estuarine Research since 1983 and has held his current position for the past eight years. His research efforts center on seagrass restoration. Before coming to the University of New Hampshire, he held research posts at the Harbor Branch Institution, the University of Alaska and the University of Rhode Island.

Response to Question 1

Response to Question 2

(top)

Question 1. How effective is habitat restoration in addressing human impacts on the coastal environment?

Click here for audio response

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Habitat restoration in coastal environments *can* be very effective, but it usually isn't. There are many examples of habitat restoration that have successfully brought back both the structure and function of specific habitat types. Certainly, preservation of existing habitats has to be the first effort, the highest priority of every regulator and manager. The cost of preserving is far less than the cost of truly restoring the functions and values of any habitat.

Restoration is often done without adequate knowledge of how to do it. Restoration ecology and technology are evolving and restoration methods are continually improving, although little opportunity exists to carry information forward from one restoration effort to another. Local experts may exist, but their experience is not used. Research money for long-term investigation of restoration methodologies is scant.

Restoration is often done in areas where continuing impacts to the environment limit the ability to achieve or sustain functional recovery. In most places, the number of restoration activities is miniscule compared to the continued onslaught of human impacts, many of which are incremental and not recognized as environmental damage. Often, regulators don't know the habitat restoration goals best suited for a particular site. Currently, little to no monitoring or follow-up occurs to see if the projects are successful over the long-term.

Despite all of these problems, restoration is, in many cases, our best hope for reestablishing the health of our coastal environments, reducing pollution and reinvigorating coastal fisheries. We just have to do it better.
(top)

Question 2. What developments are most necessary before coastal habitat restoration can adequately address the range of human impacts on the coast?

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We need to recognize that coastal habitat is valuable and that human activities at all levels can have a degrading impact on the coasts. More effort and more money are going to have to be spent. To really achieve something in coastal restoration, there have to be the political will and financial commitment to return at least some of our coastal areas to the habitats they used to be, before we started paving them over, putting Route 1 across them, and building large houses there.

Also, I think that state, federal and local governments need to get behind the idea that we can create a pool of knowledge about how to do this effectively and at least cost. We need a mechanism for transferring information and extending the knowledge base to insure that when funds are spent on restoration efforts, the best possible outcomes are achieved. Additionally, to accomplish true restoration, criteria must be tested and established that can measure the success of habitat restoration and provide objective goals.
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Joy Zedler

Professor of Biology and Director of the Pacific Estuarine Research Laboratory, San Diego State University

Dr. Zedler has been teaching at the university level for nearly 30 years. Her expertise in coastal habitat restoration comes from comparing restored and natural wetlands in southern California during the past 15 years. She has served on scientific committees and technical panels for the city of San Diego, the State of California, the National Oceanic and Atmospheric Administration, and the U.S. Environmental Protection Agency, she has also held posts on numerous editorial boards of scientific journals.

Response to Question 1

Response to Question 2

Question 1. How effective is habitat restoration in addressing human impacts on the coastal environment?

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The effectiveness of habitat restoration efforts depends on the degree of degradation of the region and the quality of the restoration site. The challenge is greatest in areas like southern California, where only a tiny fraction of the native coastal wetland habitat remains and where restoration sites are highly urbanized. In such places, the loss of habitat has led many wetland-dependent species to the brink of extinction, and bringing back their populations requires more than piecemeal restoration efforts can offer.
(top)

Question 2. What developments are most necessary before coastal habitat restoration can adequately address the range of human impacts on the coast?

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A stronger science base and a conscientious effort to incorporate science in the restoration process are the hope for the future. At Tijuana Estuary and at San Diego Bay, we use restoration sites to facilitate research and research to improve restoration. While these adaptive management efforts do not guarantee that restoration targets will be reached, the approach identifiies the causes of various problems and allows us to predict whether the target can be reached in a timely manner. Effective restoration in southern California requires that research be an integral part of the program.
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National Oceanic and Atmospheric Administration Office of Ocean Resources Conservation and Assessment. NOAA Damage Assessment and Restoration Program.

http://www-orca.nos.noaa.gov/darp/index.html

Describes NOAA's Damage Assessment and Restoration Program (DARP) which conducts natural resource damage assessments and restoration of coastal and marine resources. Provides restoration sites, relevant laws, and links to related websites.

Coastal America. Toward a Watershed Approach: A Framework for Aquatic Ecosystem Restoration, Protection, and Management.

http://www.csc.noaa.gov/coastalamerica/watershd.html

Coastal America is a collaboration of federal agencies and nonfederal partners that works to coordinate coastal restoration projects around the U.S. Describes case studies, state initiatives, nongovernmental efforts, Federal efforts, a model for watershed-based aquatic ecosystem protection (The Chesapeake Bay Partnership), and solutions relating to aquatic ecosystem restoration.

National Marine Fisheries Service. NOAA's Habitat Conservation Home Page.

http://kingfish.ssp.nmfs.gov/rschreib/habitat.html

Provides recent documents on Essential Fish Habitat, conference proceedings, articles on the Habitat Conservation Program, reports, and relevant internet links, including one to NMFS's Restoration Center, the focal point for coastal and estuarine habitat restoration within NOAA.

Save Our Wild Salmon. Save Our Wild Salmon Homepage.

http://www.desktop.org/sos

Save Our Wild Salmon (SOS) is a coalition of Northwest fishers, conservationists, scientists, business people and private citizens working to restore the declining numbers of wild salmon in the Northwest. Provides information on the Northwest's salmon crisis and the work that SOS is doing to restore the Northwest's salmon. Includes news briefs, reports, proposals, facts, and events.

Legislation Relating to Coastal Habitat Restoration

Office of Ocean and Coastal Resource Management. Coastal Zone Management Act of 1972.

http://wave.nos.noaa.gov/ocrm/czm/CZM_ACT.html

Contains the Coastal Zone Management Act of 1972, including the national policy set by Congress in sections 303.1 and 315.

National Marine Fisheries Service. Magnuson-Stevens Fishery Conservation and Management Act.

http://kingfish.ssp.nmfs.gov/sfa/magact/

Complete text of Magnuson-Stevens Fishery Conservation and Management Act, Public Law 94-265 as amended through October 11, 1996. This Act provides for the conservation and management of fisheries and requires fishery management councils to identify essential fish habitat (sections 2.104-297(2) and 303.a(7)), along with measures to conserve and enhance such habitat.

Habitat Degradation

National Wildlife Federation. Fertility on the Brink: The Legacy of the Chemical Age.

http://www.nwf.org/nwf/pubs/reports/fertility/index.html

A recent report by the National Wildlife Federation on the impacts of PCBs and other chlorinated organic compounds on humans and wildlife. Details recent scientific studies showing that hormone-imitating chemicals accumulate in animals and humans, disrupting reproduction, immunity, behavior, and metabolism.

Habitat Restoration Efforts

South Florida Ecosystem Restoration Task Force. Annual Report 1996.

http://everglades.fiu.edu/taskforce/ar1996/index.html

1996 Annual Report of the South Florida Ecosystem Restoration Working Group. Describes various Everglades ecosystem problems, restoration objectives, accomplishments, and goals.

Gottlieb, S. and M. Schweighofer. 1996. Oysters and the Chesapeake Bay Ecosystem: A Case for Exotic Species Introduction to Improve Environmental Quality? University of Maryland Center for Environmental Science.

http://cbl.cees.edu/~gottlieb/oyster.html#role

Considers the role of the oyster in the restoration of the Chesapeake Bay ecosystem. The paper suggests that the revitalization of a bivalve population is imperative to the restoration of ecosystem function, but concludes that the introduction of a non-native species of oyster would be problematic as a means of attaining that goal.

Rhode Island Save the Bay. Habitat Initiative.

http://savethebay.org/habitat/

Contains two sections: the Habitat Restoration Program, and the Plan to Restore Narragansett Bay Habitat. The first section is a physical description of Narragansett Bay and an overview of the 1995 Save the Bay Habitat Restoration Program. The second section accesses the text of the Narragansett Bay Critical Habitat Restoration Plan document.

National Oceanic and Atmospheric Administration Florida Keys National Marine Sanctuary. Coral Reef Restoration.

http://www.fknms.nos.noaa.gov/resto/resto.html

Explains the effects of two groundings that damaged the Key Largo National Marine Sanctuary coral reef in 1989 and describes the associated restoration project.
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anadromous: living in saltwater as adults, but returning to fresh water to spawn (e.g., salmon). Other fish (e.g., eels) that live in fresh water but spawn in saltwater, are catadromous.

baseline condition: the "original" state of an ecosystem, that is, its biological condition prior to an impact or injury. The goal of restoration is often to return an ecosystem to its baseline condition.

brackish: between fresh and salt; a term applied to water with salinity greater than that of fresh water, but less than that of estuarine or seawater (0.5 to 30 parts per thousand chloride). A brackish marsh, therefore, is one where the vegetative community is adapted to this salinity range. The technical term for brackish is mixohaline.

coastal habitat restoration: the range of remedies that society undertakes to repair, reinvigorate, or replace parts of the coastal environment that have been lost or made less productive as a result of human activities or natural events.

ecosystem: a discrete environmental unit, consisting of living and non-living parts interacting to form a stable system. The term can be applied at any scale, from a drop of pondwater to the entire biosphere.

eelgrass: *Zostera marina*, a common seagrass on the U.S. East Coast that serves as an important habitat for fish and shellfish.

essential fish habitat: under the Magnuson-Stevens Fishery Conservation and Management Act, those waters and substrate that fish require to spawn, breed, feed, or grow to maturity.

estuary: a semi-enclosed coastal water body where fresh water and saltwater mix.

fishery management council: a regional, quasi-governmental group with authority to manage fisheries in federal waters–generally, from 3 to 200 miles offshore.

grounding: a ship striking a shoal or reef, running aground; such an event is termed a grounding.

habitat: the living place or home of a particular organism or biological community.

habitat creation: restoration that establishes a particular habitat or ecosystem in a place where it did not previously exist.

hydrology: the study of the movement and flow of water on and below the earth's surface and in the atmosphere.

keystone species: a species or group of species whose abundance is

essential to the survival of a particular biological community.

larva (*pl*. larvae): an early life stage of an animal that, at birth, is fundamentally unlike an adult of the species and must metamorphose before assuming the adult character. Most invertebrates and fish produce eggs that hatch into larvae, then metamorphose through one or more larval stages before reaching adult form.

mitigation: restoration to compensate for a specific environmental impact, usually off-site.

PCB: polychlorinated biphenyl, a toxic, chlorinated organic compound formerly used as a coolant in electrical transformers.

quahog: the Rhode Island term for the hard clam, *Mercenaria mercenaria* , from the Narragansett Indian name, poquauhock.

salmon run: a distinct population of salmon.

salt marsh: a coastal wetland that supports vegetation adapted to brackish or saline waters. Salt marsh is classed either as low marsh, which is flooded by most high tides, or high marsh, which is flooded only by the highest tides. Each supports a distinct vegetative community.

trustee: caretaker; under the Comprehensive Environmental Response, Compensation and Liability Act and the Oil Pollution Act, Federal, state and tribal governments act as trustees for natural resources. As such, they bear responsibility for ensuring that resources injured by oil spills and other impacts are restored.

wetland: a habitat or vegetative community dependent on seasonal, intermittent, or permanent flooding.
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