CHAPTER FOURTEEN

Coastal and Marine Resources

Coastal and nearshore marine areas are some of the nation's richest, most diverse, and most productive ecosystems. Many are heavily used to fulfill human needs.

One of the notable developments of the past quarter-century has been the increased understanding of the environmental and economic benefits of coastal and marine resources. Almost 70 percent of the commercially and recreationally important species of fish and shellfish spend part of their life cycle in coastal or nearshore marine waters. At least 30 percent of North American waterfowl winter in coastal areas, and many other migratory birds depend on coastal areas for feeding, breeding, or migration rest areas. Naturally vegetated coastal habitats help to purify runoff, dissipate flood waters, trap sediments, and protect shorelines from erosion.

Although it is difficult to quantify accurately the economic benefits of these habitats and ecosystems, experts agree that coastal ecosystems contribute billions of dollars to the national economy. The National Marine Fisheries Service has estimated that the marine fishing industry contributes over $24 billion annually to the U.S. economy. The commercial shipping industry provides $52 billion in personal income in the U.S. In east-central Florida, as a local example, it is estimated that the total value of all uses of the Indian River estuary is over $700 million per year. Coastal tourism and recreation generate substantial revenues for states and localities.

BACKGROUND

The nation's coastal and marine domain is vast. It includes some 34,000 square miles of estuaries (excluding Alaska) and 95,000 miles of ocean shoreline. U.S. fisheries extend 200 nautical miles off the U.S. shoreline; beyond this Exclusive Economic Zone (EEZ)—at 3.5 million square miles, the world's largest—are international waters regulated by international laws and multilateral arrangements. (The nation's coastal zone also includes 5,559 miles of Great Lakes shoreline. See Chapter 13, "Water").

Up to 3 nautical miles from shore, resource management responsibility belongs primarily to the coastal states. Within the zone that stretches to 200 nautical miles offshore, prime responsibility for living marine resources, with some exceptions, lies with the National Marine Fisheries Service (NMFS), which is part of the Commerce Department's National Oceanic and Atmospheric Administration.

Most of NMFS's conservation responsibilities emanate from four statutes: the Magnuson-Stevens Fishery Conservation and Management Act, which regulates fisheries within the EEZ; the Endangered Species Act, which protects threatened or endangered species; the Marine Mammal Protection Act, which regulates the taking of marine mammals; and the Fish and Wildlife Coordination Act, which authorizes collection of fishery data and coordination with other federal agencies for environmental decisions affecting living marine resources. A fifth statute, the Federal Power Act, requires NOAA to protect aquatic habitat in concert with the U.S. Fish and Wildlife Service.

Fishery resources are managed within the EEZ largely through fishery management plans (FMPs), which are coordinated and developed by eight regional fishery management councils. Fishery resources are managed to protect their maximum sustainable yield. The plans are developed after extensive consultation with state and other federal government agencies, public interest groups, and in some cases international science and management organizations. In 1995, NOAA reported 39 FMPs in place.

A number of programs protect coastal and ocean waters from pollution. The Environmental Protection Agency has prime responsibility under the Clean Water Act, Oil Pollution Act, and international agreements such as the London Dumping Convention and the International Convention for the Prevention of Pollution from Ships. EPA and the U.S. Army Corps of Engineers regulate the disposal of dredged material in inland waters, including coastal areas, under Section 404 of the Clean Water Act; they regulate dredged material disposal in ocean waters under Titles I and II of the Marine Protection, Research and Sanctuaries Act (MPRSA). These programs both require that material meet stringent criteria before it is disposed of, thus protecting public health and marine resources such as fisheries.

Coastal waters are also protected by the Ocean Dumping Ban Act. Under this act, ocean dumping of industrial waste and sewage sludge was stopped in 1988 and 1992, respectively. Coastal waters are also beginning to receive better protection from another major stressor—polluted runoff. States have begun to implement management measures to reduce polluted runoff from urban and rural lands, as required by section 315 of the Clean Water Act and the Coastal Zone Management Act Reauthorization Amendments of 1990.

The Coastal Zone Management Act encourages states to produce and enforce their own coastal zone management programs consistent with federal law. The National Estuary Program encourages creation of plans to protect estuaries identified as nationally significant that are threatened by pollution, development, or overuse. The National Marine Sanctuary Program preserves and protects areas that have special significance based on their "conservation, recreational, ecological, historic, research, educational, or aesthetic qualities."

CONDITIONS AND TRENDS

Coasts and estuaries are stressed by a wide range of human activities. They receive pollutants from farmland and developed areas; support marinas, commercial fishing fleets, and recreational activities; and are highly prized areas for both commercial and residential development. These pressures have increased over the past few decades as the population in coastal areas has grown.

Nearshore ocean waters are vulnerable to pollution from numerous sources, including storm sewers, outfalls from sewage treatment plants, overboard disposal of debris and sewage, oil spills, bilge discharges that contain oil and grease, ballast discharges that contain exotic species, and a host of non-point sources.

Over the past 25 years, the United States has made substantial progress in correcting some of these problems. This includes curbing the loss and modification of some types of coastal habitats and reducing environmental loadings of some types of contaminants. However, many coastal areas continue to suffer from overutilization, loss of important habitats, and damage from pollution. One-third of the nation's assessed estuarine waters do not fully support designated uses. Nonpoint pollution sources continue to affect thousands of acres of shellfish growing waters. Nonindigenous species are increasing in coastal waters where they threaten to displace native species. And the futures of some fisheries depleted by over-utilization, habitat alteration, and other factors seem to be in question. These and other trends in coastal and marine environmental quality are reviewed in this chapter.

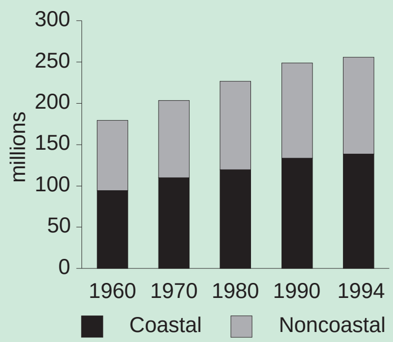
Trends in Coastal Population

Because of their rich bounty and natural transportation routes, coastal areas have been inhabited by humans since pre-historic times. Today, coastal areas support major population and industrial centers, retirement and "second home" communities, and popular tourist attractions. Population growth and development in coastal areas brings changing and sometimes conflicting land uses; pressures and demands for infrastructure and services; pollutant discharge increases from point and nonpoint sources; and possible diminution of coastal habitats and associated living resources.

The U.S. coastal zone represents only about one fourth of total U.S. land area, yet the Bureau of the Census estimates that in 1994 nearly 140 million people—roughly 53 percent of the total U.S. population—were living within the coastal zone area. Coastal corridor densities range from 69 people per square mile along the Pacific coast to over 410 people per square mile along the Atlantic coast. Regardless of coast, population density in the coastal zone far exceeds that of the interior portion of the country (Part III, Table 6).

The U.S. coastal population increased by about 44 million people from 1960 to 1994, which is slightly more than half of the total U.S. population increase (Figure 14.1). The pattern of population growth ranges from traditional growth outward from an inner city, characteristic

Figure 14.1 Coastal and Noncoastal Population, 1960-1994



Source: See Part III, Table 6.

of older urban centers in the North Atlantic and Middle Atlantic, to suburban sprawl along narrower coastal strips, characteristic of sections of the South Atlantic and Gulf of Mexico region.

Trends in Coastal Habitats

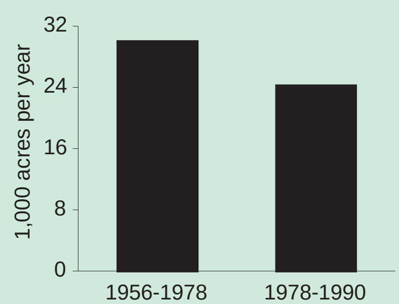
Important coastal habitats include estuaries, salt and fresh water marshes, tidal flats, estuarine forested wetlands, sandy beaches, barrier islands, seagrass beds, coral reefs, and deltas and dunes. These habitats are nurseries and spawning grounds for many commercially valuable species.

Along the Gulf of Mexico, for example, coastal wetlands and seagrass beds are diminishing. This loss is of special interest because of the role these coastal habitats play in supporting fish and shellfish of economic importance. The Gulf of Mexico is an exceptionally productive sea that, according to NMFS, yields between 1.5 and 2 billion pounds of fish and shellfish annually and contains three of the top five fishing ports in the nation (by weight of fish harvest).

According to the National Biological Service, the loss of wetlands in Louisiana is the largest of any state and accounted for 67 percent of the nation's total loss for the period 1978–90 (Figure 14.2). The rate of wetlands loss has been reduced from 30,000 acres per year in the 1956–78 period to 24,000 acres per year in the 1978–90 period. Much of the loss is due to altered hydrology stemming from navigation, flood control, and mineral extraction and transport projects. In the northern Gulf, losses of seagrass have also been extensive over the last five decades—from 20 to 100 percent for most estuaries—largely because of coastal population growth and accompanying deterioration of water quality.

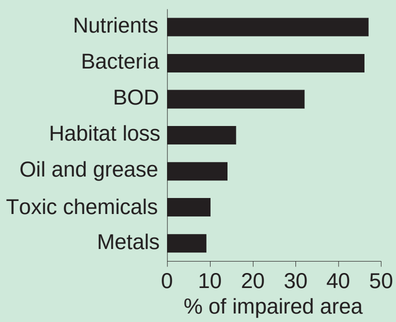
Some portion of wetland and seagrass bed losses are attributable to natural processes such as hurricanes and coastal

Figure 14.2 Louisiana Wetlands Losses, 1956-1990



Source: Johnson et al., "Gulf of Mexico Coastal Wetlands: Case Studies of Loss Trends," In: *Our Living Resources,* LaRoe et al, eds., U.S. Department of the Interior, National Biological Service (GPO, Washington, DC, 1995).

Figure 14.3 Causes of Impairment in U.S. Estuaries, 1994



Source: See Source for Part III, Table 38.
Note: Total impaired area=9,700 sq. mi. (37% of U.S. estuarine area). BOD=biochemical oxygen demand.

storms. Rising sea level and coastal subsidence (natural processes that are probably accelerated by human activities) are also causing coastal habitat losses.

Coastal barrier islands—dynamic, shifting, sandy areas such as the Outer Banks of North Carolina—are experiencing greatly increased pressures, largely as a result of development in areas of high risk. Long-term survey data by the U.S. Geological Survey show that coastal erosion is affecting each of the 30 coastal states. About 80 percent of U.S. coastal barriers are undergoing net long-term erosion at rates ranging from less than 3.3 feet to as much as 65 feet per year. Natural processes such as storms may be the immediate precipitating cause of this erosion, but human factors such as mineral extraction, construction of hard coastal structures, and dredging are now recognized as having major effects on shoreline stability. Rising sea level is also implicated in the erosion of barrier islands.

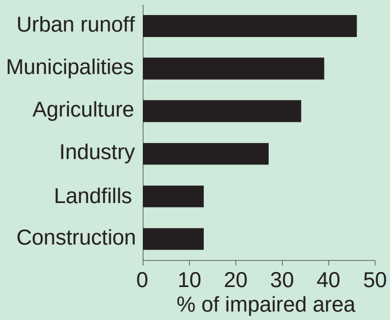
Water Quality

In 1992–93, 25 coastal states and jurisdictions surveyed 78 percent of the nation's total estuarine waters. The results, published in December 1995 in EPA's *National Water Quality Inventory*, indicate that 63 percent of the surveyed estuarine waters have good water quality that fully supports designated uses; 27 percent have fair water quality; and 10 percent have poor water quality.

Enhanced nutrient and bacteria loads are the most widespread causes of impairment in estuaries: 15 states reported that excess nutrients pollute 4,548 square miles of estuarine waters, and 25 states reported that bacteria contaminate 4,479 square miles. Oxygen depletion from organic wastes (3,127 square miles), habitat alteration (1,564 square miles), and oil and grease (1,344 square miles) also are significant environmental problems (Figure 14.3). The states reported that urban runoff and storm sewers, including combined sewer overflow discharges, are the most widespread sources of pollution in estuaries, followed by municipal sewage treatment plants, agriculture, and industrial discharges (Figure 14.4).

Where the nation's largest river, the Mississippi, discharges into the northern Gulf of Mexico, excess nutrient enrichment from anthropogenic sources is one of the major stresses on the coastal ecosystem. An extensive and severe zone of oxygen-depleted (hypoxic) waters in which fish and shrimp cannot survive forms each spring and summer off the coast of Louisiana; in summer 1995, this so-called "dead zone" covered an area

Figure 14.4 Sources of Impairment in U.S. Estuaries, 1994



Source: See Source for Part III, Table 38.
Note: Total impaired area=9,700 sq. mi. (37% of U.S. estuarine area).

estimated at 18,200 kilometers (7,032 square miles).

Between 1990 and 1996, 30 federal and academic scientists participated in the interdisciplinary Nutrient Enhanced Coastal Ocean Productivity Program (NECOP) of NOAA's Coastal Ocean Program in order to better understand this coastal ecosystem's response to nutrient enrichment. The researchers conducted a series of integrated retrospective analyses, process and monitoring studies, and modeling exercises. The results confirm suspected linkages between nutrients derived from the extensive Mississippi drainage basin and the current low oxygen conditions. NECOP findings have aroused concern over oxygen depletion in the northern Gulf of Mexico and helped managers and scientists develop a plan to deal with the problem.

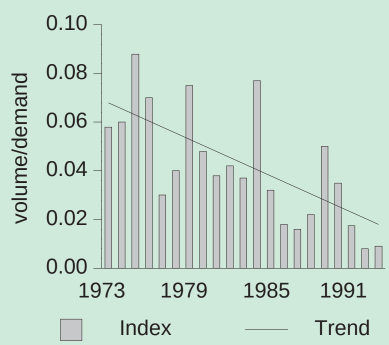
The 1994 EPA water quality report also included ocean shoreline miles, but the sample reported by the participating coastal states represents only 9 percent of the nation's ocean coastline. (States may be targeting their limited ocean coastal sampling in areas with suspected problems.) Of this area, 93 percent was reported to have good quality; only 5 percent had fair quality and 2 percent had poor quality.

Trends in Oil Spills

By nearly every measure, the volume of oil spilled in U.S. coastal waters declined during the 1973–93 period, according to a recent report by the Department of Transportation, U.S. Coast Guard (USCG).

Though interrupted by a few catastrophic events such as the 1989 *Exxon Valdez* spill and 1996 spills off Rhode Island and Texas, the general downward trend suggests that tightened regulations and the threat of severe financial penalties are having a positive effect (Figure 14.5).

Figure 14.5 U.S. Oil Spills as a Function of Demand, 1973-1993

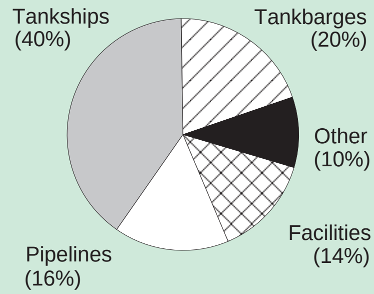


Source: U.S. Coast Guard, *Pollution Incidents In and Around U.S. Waters: A 25 Year Compendium, 1969-1993* (USCG, Washington, DC, 1996).

The USCG report found that 95 percent of all spills reported each year are less than 1,000 gallons, but these spills constitute only 5 percent of total spill volume. Of the 170,340 spills reported between 1973 and 1993, only 287 were more than 100,000 gallons, but these constituted nearly 70 percent (153 million gallons) of the total volume spilled (222 million gallons).

Although the decline in oil spill volume in recent years suggests a diminished risk of catastrophic spills, the risk may actually be increasing. Oil imports are primarily transported by tankers, which historically have been responsible for the lion's share of spill volume (Figure 14.6). Because oil imports have increased from 21 percent of domestic consumption in 1970 to about 45 percent in 1994—a trend that is expected to continue—the opportunity for accidents may be growing.

Figure 14.6 U.S. Oil Spill Volume by Source,1973-1993



Source: U.S. Coast Guard, *Pollution Incidents In and Around U.S. Waters: A 25 Year Compendium, 1969-1993* (USCG, Washington, DC, 1996).
Note: Data refer to cumulative volume (155.6 million gallons which is 70% of the total 222 million gallons) spilled from 1973 through 1993.

Trends in Coastal Contaminants

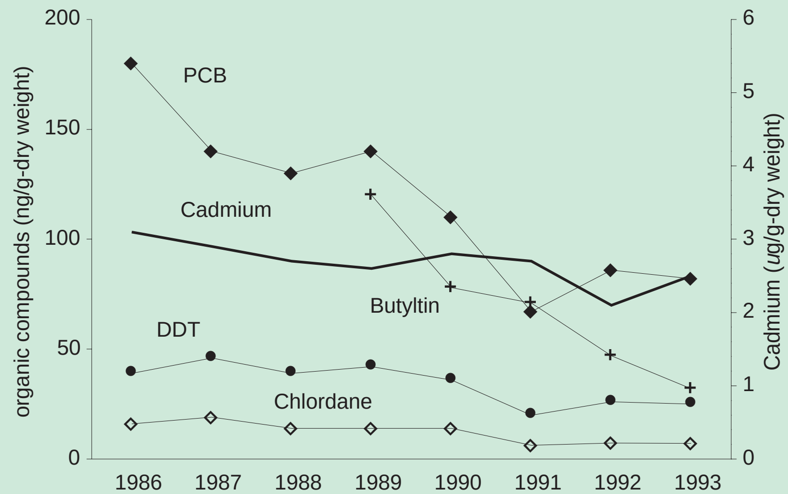
Chemical contaminants can be detected in coastal sediments and in the tissues of bottom-feeding fish and shellfish. Several federal projects monitor these contaminants.

NOAA's National Status and Trends Program measures trace metals and synthetic organic compounds in fish livers and coastal sediments at about 100 sites nationwide as part of its National Benthic Surveillance Project. Since 1986, NOAA's Mussel Watch Project has measured about 70 contaminants in mussel and oyster tissues and coastal sediments at more than 240 sites nationwide.

Not surprisingly, both projects have found that the highest concentrations are near urban and industrial areas. Using sediment cores to reconstruct the history of contamination, NOAA has found that contaminants increased slowly in the late 1800s, accelerated in the mid-1900s, and peaked around the 1970s. Since then, many contaminants have been decreasing (Figure 14.7). Lower concentration levels generally are observed for banned chemicals (chlorinated pesticides, polychlorinated biphenyl (PCB), and tributylin) and for substances whose use is declining (cadmium and arsenic). Sites with decreases in contaminant concentrations are more numerous than sites with increases.

The NOAA mollusc and fish liver projects are valuable indicators of long-term trends in sediment contamination. To a large extent for organic chemicals and to a lesser extent for trace metals, the

Figure 14.7 Mean Contaminant Concentrations in Molluscs from U.S. Coastal Waters, 1986-1993



Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, *Recent Trends in Coastal Environmental Quality: Results from the Mussel Watch Project* (NOAA, Silver Spring, MD, 1995).

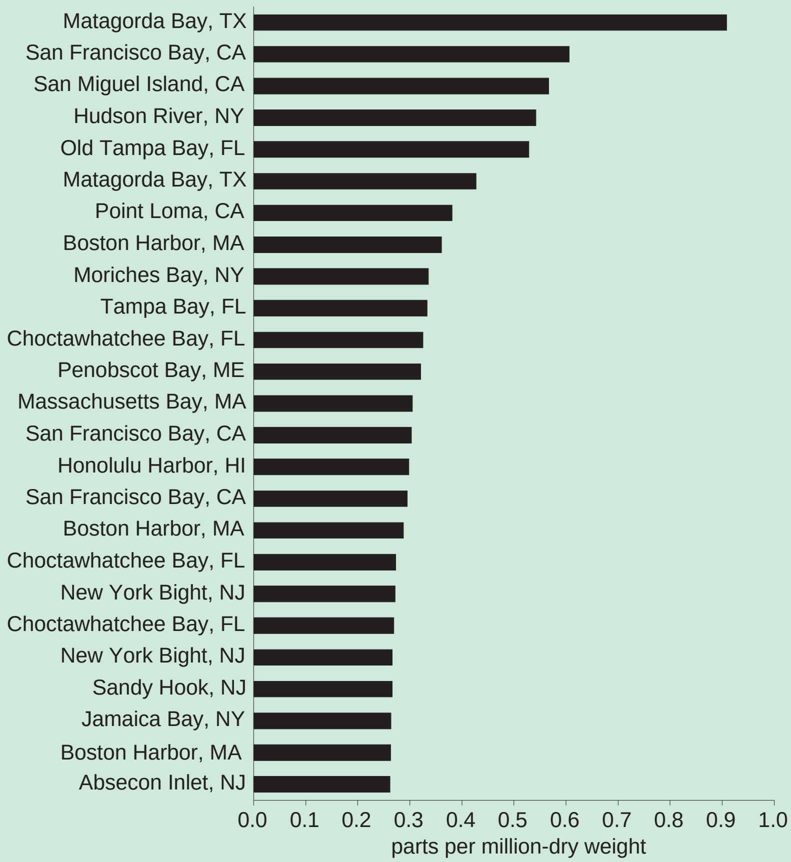
Note: PCB=polychlorinated biphenyls; sum of concentrations at each level of chlorination. DDT=dichloro-diphenyl-trichloro ethane and metsabolites. Butylin=sum of monobutylin, dibutylin, and tributylin.

national distribution of contaminants in molluscs reflects that in sediments (Figure 14.8). Similarly, high levels of contaminants in sediments were closely associated with high levels in fish livers.

Monitoring results indicate the following:

- The highest concentrations of chemicals in fish livers are near urbanized areas in the Northeast (New York City, Boston, and Baltimore) and the West (San Diego, Los Angeles, and Seattle). State advisories remain in effect warning against consumption of fish and shellfish from these areas.
- Relatively high incidences of nontumorous disease occur in fish from contaminated sites. At Morris Cove, a highly contaminated site in New Haven, Connecticut, up to 90 percent of the cells in winter flounder livers have a precancerous condition with large numbers of nonfunctioning cells.
- Fin erosion is unusual, except in a few highly contaminated sites. However, at the Houston Ship Channel at Green Bayou, Texas, up to 90 percent of the Atlantic croaker, 100 percent of the sand sea trout, and 17 percent of spot experience fin loss due to disease.
- The highest concentrations of organic contaminants in molluscan tissues are at urban sites near Boston, New York City, Mobile, San Diego, San Francisco, and Los Angeles.

Figure 14.8 Mean Mercury Concentrations in Molluscs from U.S. Coastal Waters, 1986-1993



Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, *Recent Trends in Coastal Environmental Quality: Results from the Mussel Watch Project* (NOAA, Silver Spring, MD, 1995).

Notes: Some coastal bays and harbors are listed above more than once because data are reported for more than one sampling station per location. See source document for locations of sampling stations. Another 206 stations not shown above have mean concentrations ranging from 0.045 to 0.26 ppm-dry weight.

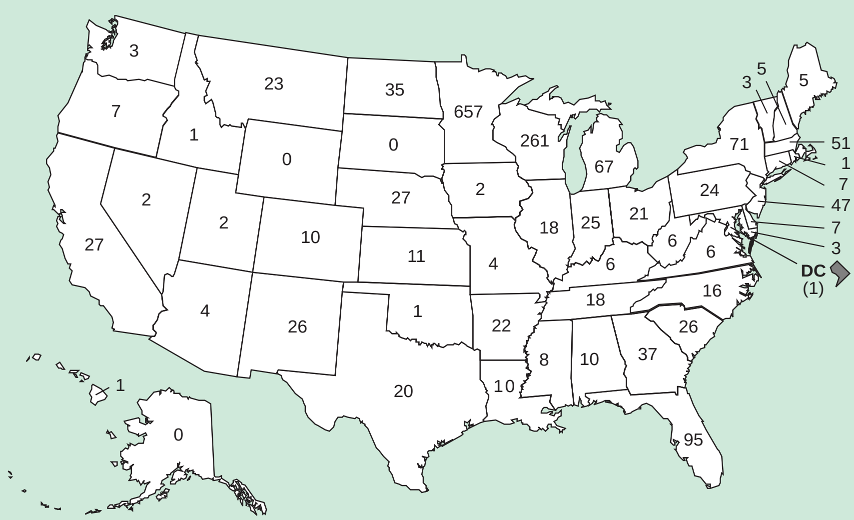
An analysis was conducted of sediment toxicity data collected during the NOAA Coastal Ocean Program's Toxic Chemical Contaminants Program from 20 bays and estuaries, encompassing over 2,200 square kilometers, in order to estimate the spatial extent of environmental degradation in U.S. coastal regions. The toxicity tests included bioassay for acute toxicity, measures of impaired fertilization or larval development, and observations of physiological responses upon exposure to contaminants.

Based on acute toxicity measurements, about 10 percent of the nation's coastal regions are estimated to be environmentally degraded. The extent of environmental degradation ranges from none in generally pristine environments such as Apalachicola Bay in Florida to 85 percent in the relatively small but heavily contaminated Newark Bay. Measurements of impaired fertilization and physiological stress indicate that approximately 50 percent of coastal regions show adverse biological responses to environmental contaminants—a figure that could be indicative of impending problems.

Trends in Fish Advisories

The number of waterbodies with fish contamination advisories reported to EPA in 1995 (1,740 advisories) represents a 14 percent increase from the number reported in 1994 (1,532 advisories) and a 36 percent increase from the number of advisories issued since 1993 (1,278 advisories). As noted in Chapter 13, "Water," the increase in advisories reflects an increase in the number of assessments of the levels of chemical contaminants in fish and wildlife tissues. A substantial number of advisories were issued in coastal states (Figure 14.9).

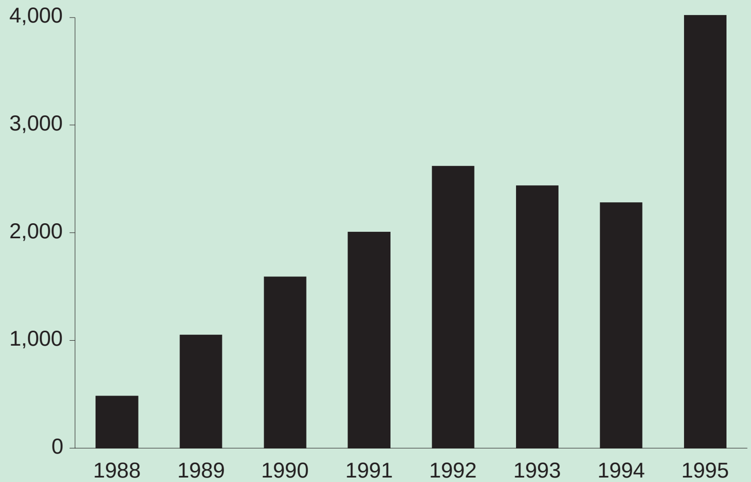
Figure 14.9 Number of Fish Consumption Advisories Issued by State, 1995



Source: U.S. Environmental Protection Agency (EPA), Office of Water (OW), *Update: National Listing of Fish and Wildlife Consumption Advisories*, Fact Sheet (EPA, OW, Washington, DC, 1996).

Note: The numbers depicted here do not necessarily reflect the geographic extent of chemical contamination in each state nor the extent of state monitoring efforts.

Figure 14.10 Number of U.S. Coastal Beach Closings and Advisories, 1988-1995



Source: Natural Resources Defense Council (NRDC), *Testing the Waters, Volume VI, Who Know What You're Getting Into* (NRDC, New York, NY, 1996).
Note: A beach closure/advisory is a single beach for which a closure/advisory has been issued for a single day. Numbers do not include permanent or extended closures/advisories. Data for 1995 include information received by NRDC after the source document was published.

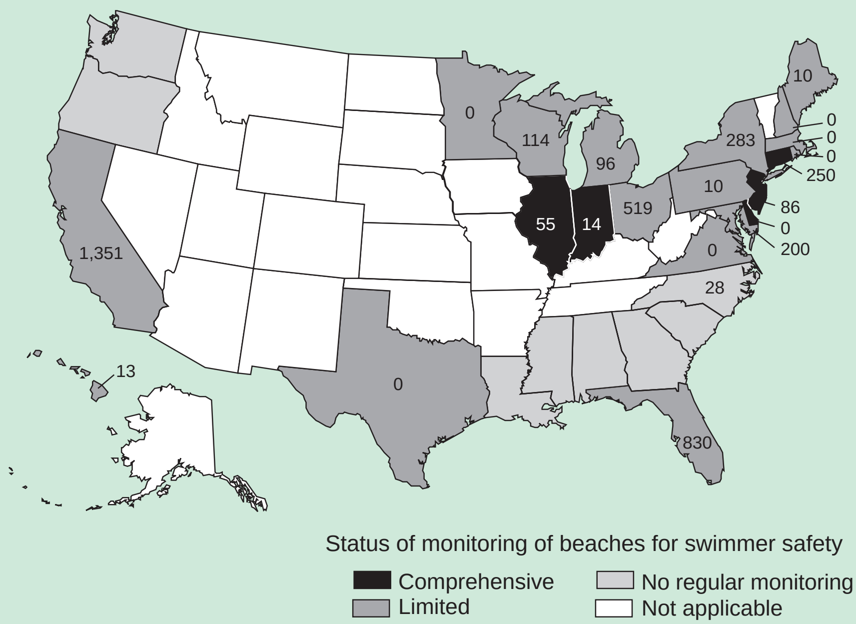
Trends in Beach Closings

Disease-carrying organisms, primarily from stormwater runoff and sewage overflows, prompted at least 4,020 closings and advisories at ocean, bay, and Great Lakes beaches in 1995, according to a study released by the Natural Resources Defense Council. This number is 76 percent higher than the 1994 tally, reversing what had been a declining trend since 1992. Since 1988, there have been over 16,492 closings and advisories (Figure 14.10). This figure could actually be higher because no standard monitoring, testing, or closure practices control beach safety and because eight states do not regularly monitor beach water for swimmer safety (Figure 14.11).

The primary sources of pollution that caused beach closings and advisories in 1995 included sewage overflows (842 closings), stormwater runoff (823), sewage treatment plant malfunctions (236), and polluted runoff (143). High levels of bacteria—indicating the presence of pathogens from human or animal waste—caused another 510 closings/advisories. The 1995 increase in closings and advisories was due in part to major storms in California and Florida that flushed pollutants into coastal waters.

Because of a wide range of diseases that can be carried by pathogens in sewage-contaminated waters, including gastroenteritis, dysentery, and hepatitis, beachwater pollution threatens the pub-

Figure 14.11 U.S. Coastal Beach Closings and Advisories by State, 1995



Source: Natural Resources Defense Council, *Testing the Waters, Vol VI, Who Knows What You're Getting Into* (NRDC, New York, NY, 1996.

Note: Numbers refer to the number of coastal beach closings and advisories.

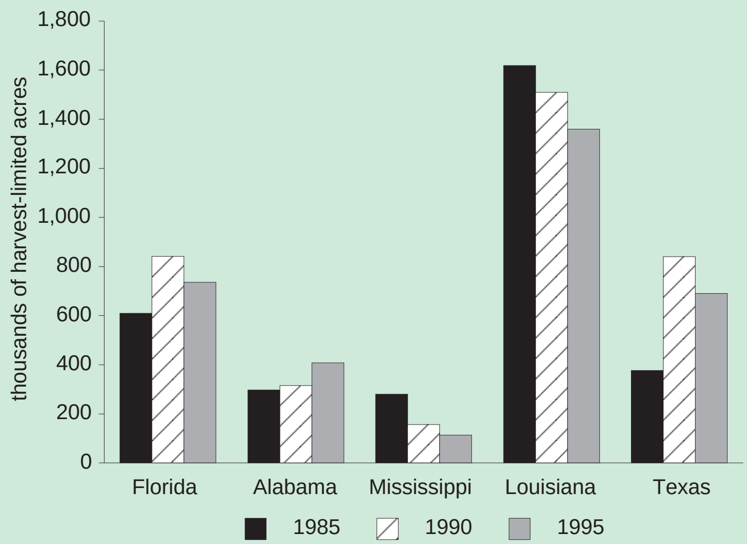
lic's health. The risk can be greater for children, elderly people, and those with weakened immune systems. A recent large-scale epidemiological study conducted in California by the Santa Monica Bay Restoration Project found that people swimming in ocean waters contaminated by urban runoff from storm drains were at greater risk of developing fever, chills, ear discharge, vomiting and other health problems than those swimming in cleaner waters. This study underscores the importance of monitoring beachwater quality and of reducing pollution sources.

Trends in Shellfish Growing Waters

NOAA's National Shellfish Register collects data on the number of shellfish-rearing areas with harvest restrictions. Harvest-limited areas (areas not available for direct marketing at all times) may be restricted for a variety of reasons, including water quality problems, lack of funding for complete surveying and monitoring, conservation measures, and other management actions.

Results from the 1995 Register are only available for the Gulf of Mexico, the largest oyster-producing region in the

Figure 14.12 Harvest-Limited Shellfish Waters in the Gulf of Mexico, 1985-1995



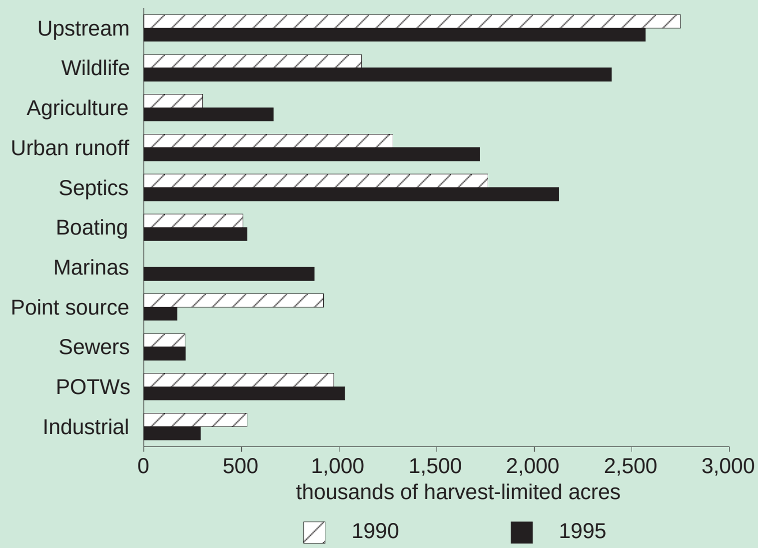
Source: See Part III, Table 43.

country. Of the 9.3 million acres of classified waters reported in 1995, 3.3 million (or 35 percent) of these waters were classified as harvest-limited. This represents a decline in the amount of harvest-limited waters from 1990, when 3.7 million acres or 52 percent of the then total classified waters (7.1 million), were classified as harvest-limited. From 1990 to 1995 there was an increase in harvest-limited acreage in Alabama; Florida, Mississippi, Louisiana, and Texas experienced decreases in harvest-limited acreages (Figure 14.12).

The top five sources of pollution most frequently cited as contributing to a harvest-limited classification in the 1995 Register for the Gulf of Mexico region were upstream sources (78 percent), wildlife (72 percent), septic systems (64 percent), urban runoff (52 percent) and wastewater treatment plants (31 percent). In contrast, the top five sources cited in the 1990 Register for this region were upstream sources (74 percent), septic systems (48 percent), urban runoff (35 percent), wildlife (30 percent), and wastewater treatment plants (27 percent).

Between 1990 and 1995 the amount of harvest-limited acreage in the Gulf of Mexico affected by wastewater treatment plants, boating, septic systems, urban runoff, agricultural runoff and wildlife increased, while that affected by industrial facilities, direct discharges and upstream sources decreased (Figure 14.13).

Figure 14.13 Sources of Pollution Affecting Harvest-Limited Shellfish Waters in the Gulf of Mexico, 1990-1995



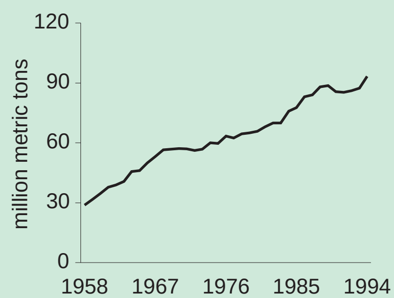
Source: See Source for Part III, Table 43.
Note: 1990 data for marinas not available.

Trends in Coastal and Marine Fishery Resources

At the global and national level, there are many troubling signs that fishery resources are imperiled. After a long period of expansion, the global fish catch (excluding aquaculture) peaked in 1989 at about 89 million metric tons and then declined to 87 million metric tons in 1993. In 1994, global fish catch rebounded to surpass the 1989 peak, primarily because of increased catch of Peruvian anchovy (Figure 14.14). The Food and Agriculture Organization of the United Nations estimates that, of 200 stocks fished worldwide, more than 25 percent are overexploited, depleted, or recovering, while 38 percent are fully exploited.

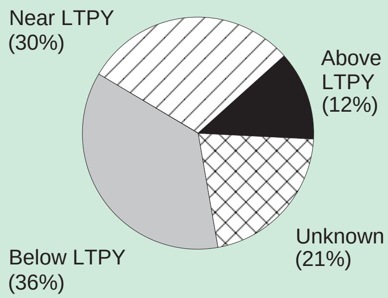
In the United States, which accounted for an estimated 6 percent of the global catch in 1994, the situation is similarly

Figure 14.14 World Commercial Fish Catches, 1958-1994



Source: Food and Agricultural Organization of the United Nations (FAO), *Yearbook of Fishery Statistics* (FAO, Rome, annual).

Figure 14.15 Abundance of U.S. Fishery Resources, 1994



Source: See Part III, Table 44.
Note: LTPY=Long-Term Potential Yield for 158 stocks.

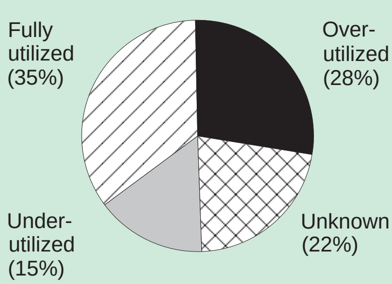
alarming. Of the 158 stock groups whose biological status is known and monitored by NOAA, 36 percent (73 groups) are currently below estimated optimum long-term levels (i.e., productivity is below the estimated long-term potential yield) (Figure 14.15). As measured in terms of fishery utilization of the resource, NOAA estimates that 28 percent (56 of 157 known stock groups) are overutilized (Figure 14.16).

Of the 56 overutilized stocks, fully one third (18 stocks) occur among the demersal fisheries (groundfish and flounder) in the Northeast. In addition, 10 stocks or stock groups of Atlantic and Gulf of Mexico reef fish are overutilized at dockside.

In 1994, U.S. fishermen landed a total of 4.7 million metric tons, valued at a record $3.81 billion. In 1995, total landings declined to 4.5 million metric tons, valued at $3.77 billion (Figure 14.17). The total catch has more than doubled since 1970, but catch reductions from 1994 were evident for many of the major species such as Pacific hake, Atlantic mackerel, tuna, American lobster, blue crab, oysters, and Atlantic squid. Finfish accounted for 87 percent of total landings, but only 52 percent of total value.

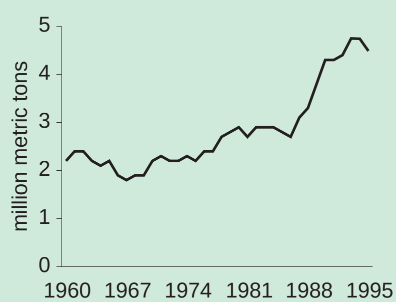
Groundfish and flounder in the Northeast—particularly cod, haddock, and yellowtail flounder—have been severely overfished. Their overall abundance in 1994 was the lowest on record (Figure 14.18). Dogfish and skate, which increased in abundance as more com-

Figure 14.16 Utilization of U.S. Fishery Resources, 1994



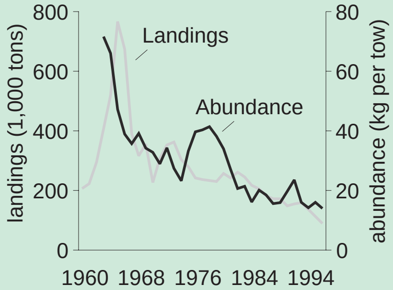
Source: See Part III, Table 44.
Note: Based on 157 "known" stocks.

Figure 14.17 U.S. Commercial Fish Catches, 1960-1995



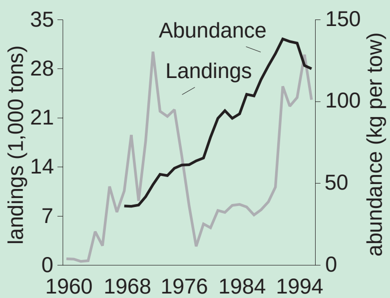
Source: National Marine Fisheries Service (NMFS), *Fisheries of the United States* (NMFS, Washington, DC, annual).

Figure 14.18 Northeast Groundfish and Flounder, 1960-1994



Source: National Marine Fisheries Service (NMFS), *Our Living Oceans* (NMFS, Washington, DC, 1996).

Figure 14.19 Northeast Skate and Dogfish, 1960-1994



Source: National Marine Fisheries Service (NMFS), *Our Living Oceans* (NMFS, Washington, DC, 1996).

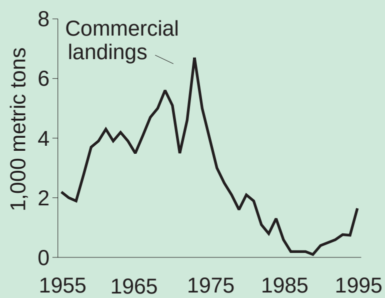
mercial groundfish species were declining, now make up about 75 percent of the total fish biomass in the region and have supported increased catches until relatively recently (Figure 14.19). Beginning in 1990, their abundance also declined.

Most of the Northeast region's fisheries are included in fishery management plans, but few of these plans have been successful in preventing overexploitation. An amendment to the Northeast Multispecies Plan, which was debated for several years and finally implemented early in 1994, was intended to limit commercial fishing of groundfish in New England and prevent the issuance of new vessel permits in this overcapitalized fishery. By early 1994, however, stocks had collapsed so severely that NMFS imposed an emergency closure of portions of Georges Bank and a moratorium on fishing for haddock. In 1995, another amendment to the Northeast Multispecies Plan was developed to reduce fishing mortality on critically overfished groundfish while avoiding increased exploitation on stocks in the Gulf of Maine and Middle Atlantic that could result if effort were transferred from one area to another. Canada continues to maintain severe restrictions on its own groundfish fishery on Georges Bank to promote stock rebuilding. Recovery of these stocks is expected to take 6 to 9 years.

Among other national stocks, trends are mixed:

- Off the Atlantic coast, the anadromous striped bass, driven to very low levels of abundance in the early 1980s and subjected to severe catch restrictions beginning in the mid-1980s, was declared fully restored in early 1995 (Figure 14.20). The Northeast's valuable crustaceans and bivalve molluscs, both offshore (e.g., American lobster, sea scallop, surfclam, ocean quahog) and inshore (e.g., blue crab, oyster, blue mussel, hard and softshell clam), are fully or overexploited.
- In the Southeast, the three major shrimp species (brown, white, and pink) are considered fully utilized in

Figure 14.20 Chesapeake Bay Striped Bass, 1955-1995



Source: National Marine Fisheries Service (NMFS), *Fisheries of the United States* (NMFS, Washington, DC, annual).

both the Gulf of Mexico and the Atlantic.

- Among pelagic species in the Northeast and Southeast, bluefin tuna is well below the biomass level required for maximizing long-term yield. The marlins (white and blue) are below optimum levels as well, although blue marlin appears to be increasing. Swordfish has recently declined to a level below its maximum long-term yield. Yellowfin tuna is currently fully exploited and near its maximum long-term yield. Bigeye tuna exploitation has increased recently, but current yields are not expected to be maintained.

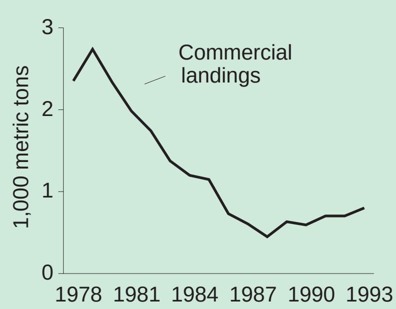
- Large coastal sharks (as a group) may be overutilized, but the status of each species is currently unknown. Because they grow and mature slowly, large sharks may be particularly vulnerable to overfishing.

- Spanish mackerel appears to be fully utilized in both the Gulf of Mexico and the Atlantic. King mackerel has been overfished in the Gulf, and a stringent rebuilding program has been in place for the last several years. King mackerel in the Atlantic may have some additional yield potential. The status of other coastal migratory pelagic species in the region is unknown.

- Most reef fishes are either fully utilized or overutilized. In the Gulf of Mexico, red snapper is overfished, and rebuilding the fishery hinges on the reduction of bycatch of juveniles in the Gulf shrimp fishery. In the Atlantic, many of the key reef fish species are considered overutilized (e.g., vermilion and other snapper, red porgy, several kinds of grouper, amberjack, jewfish). In the Caribbean, where Nassau grouper and jewfish are considered overutilized, landings of traditional reef fish have declined (Figure 14.21).

- The status of drum and croaker stocks is largely unknown. Many of the smaller species could also be heavily impacted from bycatch of the

Figure 14.21 Reef Fish in U.S. Caribbean Waters, 1978-1993



Source: National Marine Fisheries Service (NMFS), *Our Living Oceans* (NMFS, Washington, DC, 1996).

shrimp fleet. Red drum harvests in the Gulf and South Atlantic EEZ have been prohibited (the popularity of "blackened redfish" in the 1980s stimulated a significant demand for red drum so that in a few years the stock became seriously depleted), and harvests in state waters have been reduced for several years because of low spawning levels. Recovery is expected.

• Weakfish bycatch in the Atlantic is becoming a major management issue. On November 22, 1995, NMFS announced a ban on fishing for Atlantic coast weakfish in federal waters from Maine to Florida. The ban will remain in effect until the stock recovers. State waters will remain open for weakfish fishing under the guidelines of the Atlantic States Marine Fisheries Commission's weakfish management plan.

• In Alaska, salmon stocks have produced bumper harvests in recent years. Five species of Pacific salmon (chinook, coho, sockeye, pink, and chum) contribute to the catch.

• In the Bering Sea and Aleutian Islands, the major species groups harvested are walleye pollock, Pacific cod, flatfish, Atka mackerel, rockfish, and sablefish. Except for Greenland turbot, all flatfish species are high in abundance and in excellent condition. Walleye pollock and Pacific cod abundances are much lower than their recent high levels, but are still close to long-term sustainable levels. Overall abundance of groundfish in the Gulf of Alaska has been relatively stable, except for walleye pollock, which is down. Shrimp resources are down throughout Alaska. King crab resources are depressed, but Tanner crab stocks are still relatively high.

• On the Pacific coast, the major fisheries are salmon, coastal pelagics, groundfish, Pacific halibut, and nearshore resources. Most stocks, including all five species of Pacific salmon, are fully utilized or overutilized. Depressed production is partly due to ocean conditions that have been generally unfavorable for salmon off the Pacific coast since the late 1970s. Coastal pelagic fishes are low in abundance, and all, except jack mackerel, are fully utilized. Jack mackerel is one of the few underutilized Pacific coast species. The Pacific sardine population has been increasing after decades at low abundance levels. Most shellfish species are fully utilized.

• In the Western Pacific region (the Hawaiian Islands and the U.S. territories of American Samoa, Guam, and the Northern Marianas), fishery resources include highly migratory pelagic fish, bottomfish, nearshore reef fish, and invertebrates. Of the 15 stock groups of highly migratory pelagics (tuna, swordfish, and so forth), 12 stocks are near their long-term sustainable levels. Among Western Pacific bottomfish (snapper, jack, grouper, emperor), which are harvested from a variety of rock and coral habitats (mainly around Hawaii), stock assessments indicate that some important species are only at 10 to 30 percent of original stock levels, and overutilization is a concern. Spiny and slipper lobsters, which are primarily fished in the northwestern Hawaiian Islands, peaked during the mid-1980s, but have since declined. The primary cause of the decline is thought to be a general reduction in lobster productivity and recruitment since 1989, stemming from oceanographic changes. Since 1991, emergency closures, a limited entry regime, and a closed season were adopted to rebuild the stocks, which are now recovering.

Trends in Nonindigenous Coastal and Marine Species

The number of nonindigenous species in Long Island Sound, San Francisco Bay, Los Angeles Harbor, and most other estuaries, ports, and harbors around the country is increasing steadily, in large part as a result of travel by ocean-going ships to and from foreign countries. Ships take on ballast water in their home ports; when they reach their destination, they discharge their ballast, including any aquatic species in the water. Foreign organisms then may become established in U.S. waters and threaten the sustainable populations of native species either by being predatory or by competing for food and habitat. Examples include:

- a half-dozen species of Chinese and Japanese copepods are now found from the Columbia River in Washington to the San Francisco Bay in California;
- the Japanese shore crab *Hermigrapsus sanguineus* is well established and spreading rapidly along the Atlantic coast from the Chesapeake Bay to Cape Cod;
- three species of Eurasian fish, one species of waterflea, and two species of zebra mussels have invaded the Great Lakes; and
- the South American mussel *Perna perna* has become established on the Texas Gulf coast, and the Indo-Pacific mussel *Perna viridis* has invaded the lower Caribbean.

These non-native species disturb the natural ecosystem and can cause direct adverse economic impact. Zebra mussels in the Great Lakes, for example, have caused hundreds of millions of dollars in damages and required maintenance actions to remove them from boat hulls, navigation buoys, and municipal and industrial water-intake pipes (see also Chapter 8, “Biodiversity”).

RECENT DEVELOPMENTS

The difficulties in protecting coastal and marine resources include overlapping political jurisdictions, a multitude of stakeholders, and a lack of knowledge of cause-and-effect linkages involving natural and social systems. The complexity of these efforts is illustrated by current initiatives to restore shellfish beds in Puget Sound, to restore the Florida Everglades, and to rebuild groundfish stocks in the Northeast.

Cooperation in the Puget Sound

Restoring the health of the shellfish beds in the Puget Sound has required a number of measures. Since the mid-1980s, the state of Washington has prohibited or restricted oyster harvesting on nearly 45,000 acres of shellfish beds—one quarter of all available grounds in Puget Sound.

Because sources of pollution into the Sound included agricultural runoff and private septic systems, a major campaign was launched to identify and upgrade failing septic systems in the watershed. About 100 farmers teamed with a local conservation district to cover manure piles, construct fences along steams to keep animals out, and rotate grazing areas to reduce erosion runoff.

These and other steps have helped reduce contamination in the sound. More than 20,000 acres of shellfish beds remain closed, but clam and oyster harvesting has recently opened again in at least four areas.

Everglades Restoration

The Florida Everglades, with its vast area and long history of engineered alterations, presents a massive and complex restoration challenge. In response to intense flooding in south Florida and pressures to create more agricultural acreage, a complex system of public canals, levees, pumping stations, and other structures was built (largely in the 1920s and 1930s) to control the water and make the land more suitable for farming and urban development. As a result, about half of the Everglades wetland area was drained and converted to agriculture or urban development. Over time, these alterations contributed to the near collapse of the Everglades ecosystem. Ninety percent of the wading birds are gone, the estuarine fisheries have declined, and dozens of species are listed as threatened or endangered.

In recent years, a variety of public and private efforts have begun to restore the hydrologic functions of the Everglades, including the following:

- In January 1996, the Clinton Administration announced a comprehensive restoration program, including $1.5 billion in federal assistance. Among other things, the funding is to be used to acquire, in partnership with the state, enough land to make restoration a reality, including the purchase and reconversion of farmlands in the Everglades agricultural area and lands threatened by development along the eastern portion of the Everglades. The funding will also be used to continue work on the Kissimmee River, to initiate a number of restoration projects in Central and South Florida, to establish wetlands to serve as natural filters for phosphorus and other pollutants, and develop a multispecies recovery plan.

- In April 1996, Congress passed and the President signed the 1996 Federal Agricultural Improvement and Reform Act (otherwise known as the 1996 Farm Bill), which made available $200 million for land acquisition and other activities useful for Everglades restoration.

- A federal interagency research program was initiated in 1994 to quantify the health of the Florida Bay and to develop specifically tailored information products to assist with understanding potential effects of proposed Everglades restoration activities on the water quality and living resources of the Florida Bay and Keys.
- In 1993, Florida and the Army Corps of Engineers began the task of converting the Kissimmee River from an "engineered" channel back into its more natural, riverine form. In addition, a special federal task force on south Florida ecosystem restoration was created to improve coordination among the federal, state, and tribal interests in the area.
- The state and the sugar industry agreed to work together to reduce phosphorus loadings by 75 percent.
- A "Save Our Everglades" campaign has helped to acquire and protect over 326,000 acres of land.

These efforts are beginning to pay off, although much work remains to be done. Hydrologic improvements have helped rid the ecosystem of exotic species that invade and disrupt the area's natural vegetation and habitat. In the past 3 years, phosphorus levels in waters discharged from farmland north of the Everglades have been cut by about 30 percent.

Rebuilding Groundfish Stocks in the Northeast

In the Northeast groundfish crisis, a critical part of the problem is overcapacity in the fishing industry. Simply allowing the industry to shrink, however, could have a drastic economic impact on fishing-dependent communities.

To help cushion the blow, the Clinton Administration provided $25 million in disaster relief funds in August 1995. The money is for a vessel and permit buyout program that retires fishing vessels and buys back existing permits.

The buyout effort began with a $2 million demonstration program that attracted 114 vessel owners with vessels worth $52 million. Had the program been funded enough to accept all 114 applications, more than 31 percent of all fleet capacity could have been eliminated in the Northeast.

Thirteen applicants were chosen in October 1995 for inclusion in the demonstration program. Collectively, they produce about 2.6 percent of all revenues from the regulated groundfish species. They were chosen through a scoring formula that ranked offers according to the least scrapping cost per dollar of previous groundfish production. With the success of the demonstration, the remaining $23 million will be available for an expanded buyout program.

Complementing the vessel buyout program is a research project, the U.S. Global Ecosystems Dynamic Program, which is funded jointly by NOAA's Coastal Ocean Program and the National Science Foundation. Its primary objective is to understand how climate variability affects the distribution, abundance, production, and population dynamics of zooplankton and fish populations in the sea in order to improve resource management. Recovery of the fisheries on Georges Bank is a central theme of the program. Management plans have been initiated to limit fishing and to rebuild the groundfish stocks. Knowledge of current and historical physical and biological processes will contribute to improved understanding of changes in the fish stocks during recovery.

These are just a few examples of how the federal government works with communities to address environmental problems that have critical implications for the local, regional, or national economy. Other major efforts to protect coastal and estuarine resources include the National Estuary Program (NEP) and the federal interagency partnership Coastal America.

The National Estuary Program was established by Congress in the 1987 amendments to the Clean Water Act and is administered by the EPA (see also Chapter 7, "Ecosystems"). The goal of the NEP is to help communities protect and restore the health of their estuaries while supporting economic and recreational opportunities. This is achieved by forming a partnership involving all levels of government, businesses, environmental organizations, citizens, and academia. Through the partnership process, the community defines the estuary's priority problems and the actions that can be taken to protect and restore the estuary's health. The program now includes 28 estuaries. These serve as models for effectively integrating federal, state, and local environmental activities in ways that avoid duplication of effort while ensuring that problems get addressed. A major benefit of the program is that it provides a way to apply the lessons learned more broadly in other communities.

Similarly, Coastal America joins the forces of federal agencies with State, local, and private alliances to address collaboratively environmental problems along the nation's coasts. The federal partners in this effort include those agencies with principal responsibility for the stewardship of coastal resources, those with responsibilities for infrastructure development and maintenance, and those whose activities can impact coastal environments. Specifically, it includes the Executive Office of the President and the following agencies: Department of Agriculture, Department of Defense, Department of the Army, Department of Commerce, Department of Energy, Department of Housing and Urban Development, Department of the Air Force, Department of the Interior, Department of the Navy, Department of Transportation, and the Environment Protection Agency.

Coastal America's collaborative, interagency structure enables national policy issues to be identified and resolved, regional plans to be developed, and local restoration projects to be implemented. Since 1992, 150 restoration and protection projects in 26 states, two territories, and the District of Columbia have been undertaken in collaboration with over 300 nonfederal organizations. Through these partnerships, thousands of acres of wetlands are being restored, hundreds of miles of streams for anadromous fish are being reestablished, and habitat for endangered species of fish, birds, and mammals is being protected.

FUTURE CHALLENGES

As population and economic growth continue, coastal and marine resources face increasing stress from environmental pollution and overexploitation. Improving coastal waters will require improving habitat protection and enhancement, controlling pathogens from sewer system overflows, further reducing toxic pollution and eutrophication, and preventing marine debris. These actions will be particularly important in rapidly growing states such as Florida, where the need for careful management and protection will only grow stronger.

Because fish and shellfish are valuable and self-perpetuating, there are strong incentives for careful management and protection. In cases where resources are threatened by overutilization, careful management will be required and managers may have little choice but to impose moratoria or reduce utilization. Clearly, the preferred choice is to manage such resources on a long-term sustainable basis and avoid future crises. Avoiding such crises will require close monitoring and a willingness to respond quickly to early signs of trouble.

Other coastal resources, such as coral reefs and seagrass beds, have direct and indirect economic value for commercially valuable species and for tourism and recreation. These resources may be at greater

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