

**PART V**  
**CLEAR WATERS AHEAD:**  
**COASTAL AND OCEAN WATER QUALITY**

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## CHAPTER 14: ADDRESSING COASTAL WATER POLLUTION

*Coastal waters are subject to cumulative impacts from a variety of pollutants—from near and far, and from point, nonpoint, and airborne sources. For this reason, any solution must be founded on an ecosystem-based and watershed management approach involving a broad range of agencies, programs, and individuals. Solutions will also require a substantial financial investment and will take time. Over the last few decades, great strides have been made in controlling water pollution from point sources, although further improvements could be realized through increased funding, strengthened enforcement, and promotion of innovative approaches such as market-based incentives. However, substantial enhancement of coastal water quality will require significant reductions in nonpoint source pollution—a technical and political challenge. Establishing measurable pollution reduction goals for coastal areas is needed, as is coordination of the many related agencies and programs to effectively target the various laws, programs, funds, training, technical assistance, incentives, disincentives, and other management tools to address nonpoint source pollution of coastal waters.*

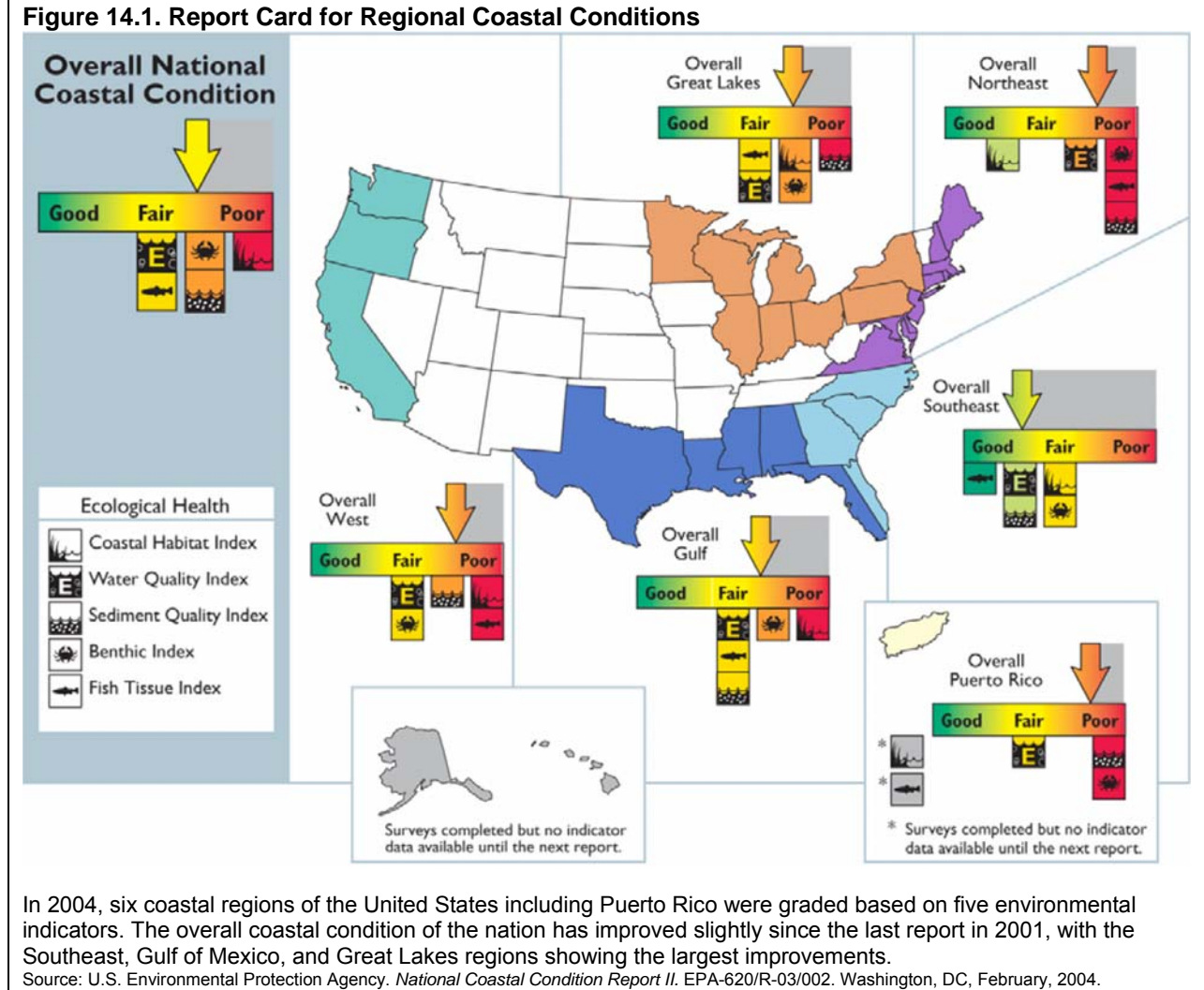
### STOPPING THE DEGRADATION OF COASTAL WATERS

Coastal waters are one of the nation's greatest assets, yet they are being bombarded with pollution from all directions. The heavy concentration of activity in coastal areas, combined with pollutants flowing from streams far inland and others carried through the air great distances from their source, are the primary causes of nutrient enrichment, hypoxia, harmful algal blooms, toxic contamination, sedimentation, and other problems that plague coastal waters.

The U.S. Environmental Protection Agency's (EPA's) 2002 *National Water Quality Inventory* found that just over half of the estuarine areas assessed were polluted to the extent that their use was compromised, either for aquatic life, drinking water, swimming, boating, or fish consumption.<sup>1</sup> EPA's 2004 *National Coastal Condition Report II* rated coastal waters along most of the continental United States as being in fair condition, with poor conditions in the Northeast and Puerto Rico regions (Figure 14.1).

The protection of coastal waters will require managers to address a range of human activities that generate pollution in many locations and a variety of pollutants following different pathways. Management that is ecosystem-based and that considers entire watersheds will help guide this daunting task.

Figure 14.1. Report Card for Regional Coastal Conditions



In 2004, six coastal regions of the United States including Puerto Rico were graded based on five environmental indicators. The overall coastal condition of the nation has improved slightly since the last report in 2001, with the Southeast, Gulf of Mexico, and Great Lakes regions showing the largest improvements.

Source: U.S. Environmental Protection Agency. *National Coastal Condition Report II*. EPA-620/R-03/002. Washington, DC, February, 2004.

The complex array of laws, agencies, and programs that address water pollution, and the number of parties involved, will require greatly enhanced coordination among federal agencies, primarily EPA, the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Agriculture (USDA), and U.S. Army Corps of Engineers (USACE). Greater coordination is also needed between the federal government and managers at the state, territorial, tribal, and local levels, watershed groups, nongovernmental organizations, private stakeholders, and the academic and research communities. The case of nutrient pollution, detailed in the following box, illustrates many of the challenges involved in improving coastal water quality.

### Nutrient Pollution in Coastal Waters

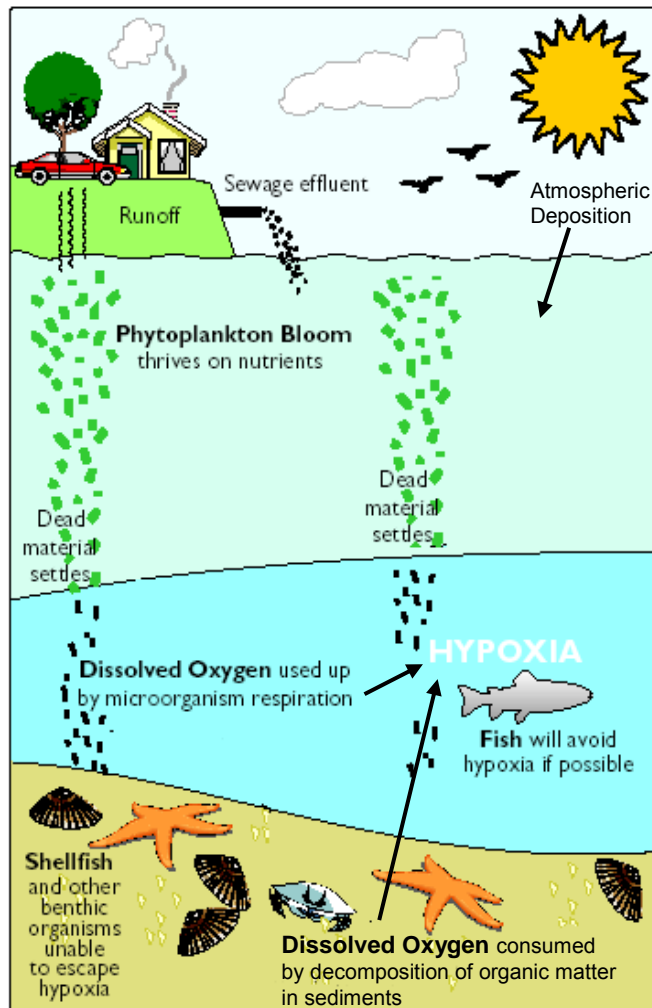
A 2000 National Research Council report called nutrient pollution the most pervasive and troubling pollution problem currently facing U.S. coastal waters.<sup>2</sup> Although nutrients such as nitrogen and phosphorus are necessary to marine ecosystems in small quantities, human activities on the coasts and inland have greatly increased the flow of nutrients—in some cases to harmful levels (Figure 14.2).

Nutrient pollution defies simple categorization and is difficult to control because it can come from point, nonpoint, and atmospheric sources, from near and far. The main sources include runoff from agricultural land, animal feeding operations, and urban areas, discharges from wastewater treatment plants, and atmospheric deposition of chemicals released during fossil fuel combustion. Human activities have approximately doubled the amount of reactive nitrogen cycling through the biosphere compared to pre-industrial conditions, with most of this increase occurring during the last thirty years.<sup>3</sup> The largest human additions of nitrogen stem from an increased use of inorganic fertilizers.<sup>4</sup>

Nutrient pollution leads to a host of ecological and economic impacts including: fish kills due to oxygen depletion; loss of important and sensitive coastal habitats; excessive and sometimes toxic algal blooms; changes in marine biodiversity; increases in incidents of human illness; and reductions in tourism. The greatest impacts occur in estuaries and nearby coastal regions. Nutrient pollution has been particularly severe along the lower Atlantic Coast and in the Gulf of Mexico. The infamous “dead zone” in the Gulf of Mexico is an area of seasonal oxygen depletion caused by nutrients draining from the Mississippi River Basin.

Smaller dead zones are becoming increasingly frequent in other estuaries. The severity and extent of nutrient pollution are expected to worsen in more than half of the nation’s estuaries and coastal waters by 2020.<sup>5</sup> Without concerted, coordinated, and sustained action to reduce nitrogen sources, nutrient pollution will be a continuing problem in the nation’s coastal waters.

**Figure 14.2. Land-based Nutrients Can Cause Death on the Seafloor**



When ocean water becomes enriched in dissolved nutrients, from sources such as agricultural runoff and sewage outflows, these nutrients stimulate the growth of phytoplankton. As the phytoplankton die and sink to the bottom, their decomposition consumes the dissolved oxygen that other benthic organisms need to survive.

Source: U.S. Environmental Protection Agency. *National Coastal Condition Report*. EPA620-R-01-005. Washington, DC, August, 2001.

## REDUCING POINT SOURCES OF POLLUTION

With strong public support, government and private sector actions over the past three decades have made great strides in controlling water pollution from identifiable point sources, such as industrial facilities and wastewater treatment plants, whose discharges can be monitored as they emerge from the end of a pipe. Even so, opportunities remain to further reduce point source impacts on U.S. coastal waters and improve compliance with existing environmental requirements.

### Existing Management Tools

Point source pollution is primarily addressed through the National Pollutant Discharge Elimination System and the State Revolving Loan Fund, two longstanding EPA programs.

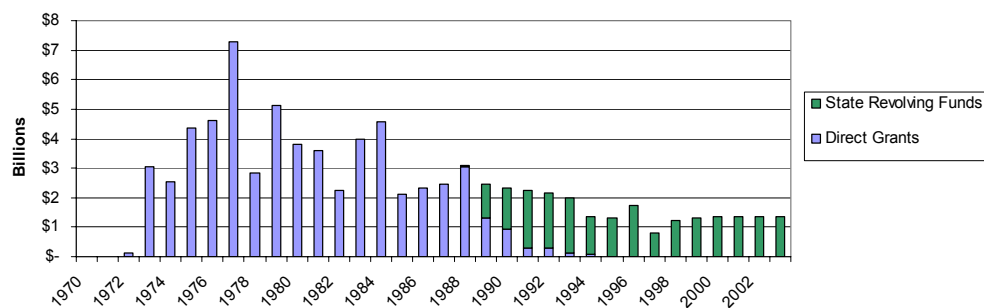
#### *The National Pollutant Discharge Elimination System*

Over the past thirty years, the Clean Water Act and its National Pollutant Discharge Elimination System have led to dramatic reductions of polluted effluents. EPA typically delegates administration of this program to the states, and the state or EPA then regulates polluters by issuing permits that reflect federal standards for discharges. If the regulatory agency determines that a particular water body is not meeting water quality standards, permittees discharging to those waters may be required to implement more stringent controls.

#### *State Revolving Loan Funds*

Under the Clean Water Act, the federal government has provided significant financial support for water quality infrastructure improvement. From 1970 to 1995, funding was provided under the Federal Construction Grants Program to build publicly owned treatment works and collection systems, without any requirement for repayment. In 1987, in a major shift in policy, Congress established and began to fund the State Revolving Fund Program, in which the federal government provides capitalization grants for a more self-sustaining, state-administered revolving loan fund (Figure 14.3). States decide which projects are the highest priorities for funding, the borrowers repay the loans, and the program loans the money again to other borrowers. States provide below-market interest rates and other financial incentives to towns, counties, nonprofit organizations, farmers, and homeowners for water quality improvement projects. The funds finance capital construction costs—not operations and maintenance—and are mostly used to build wastewater treatment plants.

**Figure 14.3. Clean Water Relies on Recycled Money**



In the last thirty years, there has been a fundamental shift in the way the federal government funds the infrastructure for water pollution control in local communities. From 1970 to 1995, EPA provided \$61.1 billion in direct grants to help build or upgrade publicly owned wastewater treatment facilities. However, since 1988 the EPA has increasingly supported these types of projects through state revolving loan funds, which provide low interest loans that are paid back into the account to fund future projects.

Source: U.S. Environmental Protection Agency. *Progress in Water Quality: An Evaluation of the National Investment in Municipal Wastewater Treatment*. EPA-832-R-00-008. Washington, DC, June, 2000.

This program is widely considered a cost-effective, long-term mechanism for meeting infrastructure demands. From 1998 to 2002, the funds provided an average of \$3.8 billion per year for water quality improvement. Since the program's inception, a total of \$38.7 billion has been disbursed.<sup>6</sup> State revolving loan funds are crucial to restoring, maintaining, and improving the nation's water quality.

## Major Point Sources

The major point sources of pollution to the nation's waterways include wastewater treatment plants, sewer system overflows, septic systems, industrial facilities, and animal feeding operations.

### *Wastewater Treatment Plants*

Municipal wastewater consists primarily of wastewater from individual households and from manufacturing and commercial activities. Wastewater entering a treatment plant may contain organic pollutants, metals, nutrients, sediment, bacteria, viruses, and toxic substances. Wastewater treatment plants have met their original goal of removing most pathogens, organic materials, and suspended solids; however, nutrients and many chemicals are not effectively removed with existing treatment processes. The effluent from treatment plants can be discharged into fresh water or directly into estuaries, coastal waters, and oceans. Even discharges into waters far upstream can have serious impacts on coastal waters.

Although nutrient pollution has had a major impact on coastal waters, both primary and secondary wastewater treatment have been effective in adequately removing nitrogen and phosphorus. In many heavily developed areas, existing wastewater treatment is unlikely to achieve nutrient-related standards; additional controls will be needed to meet water quality goals.

Advanced—or tertiary—treatment technologies, which can remove most nitrogen and phosphorus from wastewater treatment plant discharges, cost approximately 25 percent more than secondary treatment.<sup>7</sup> These advanced technologies are being implemented in regions where wastewater discharges are significant sources of nutrient pollution, such as Tampa Bay and Chesapeake Bay. One recent success in developing and applying advanced treatment was at a Stamford, Connecticut wastewater treatment plant where a novel biological nutrient process removed much of the nitrogen at very little cost.<sup>8</sup>

Conventional treatment plants have been generally ineffective in removing many of the household and industrial chemicals present in wastewater. These chemicals—including pharmaceuticals, antibiotics, hormones, insecticides, and fire retardants—are then discharged to surface waters. Although many of these compounds may break down in the environment, their cumulative loading is substantial. Significant concentrations of many commonly used chemicals, including over-the-counter pharmaceuticals, have been detected in some coastal and ocean waters.<sup>9</sup> These compounds, designed to produce biological effects in humans, may have unforeseen impacts on aquatic life. For example, the effluent from wastewater treatment plants has been shown to disrupt endocrine functions in some aquatic organisms.<sup>10</sup>

**Recommendation 14–1. The U.S. Environmental Protection Agency (EPA) and states should require advanced nutrient removal for wastewater treatment plant discharges into nutrient-impaired waters. Additionally, EPA should support a vigorous effort to characterize the extent of the impact of household and industrial chemicals in wastewater.**

*In particular, EPA should:*

- *support research and demonstration projects for biological nutrient removal and other innovative advanced treatment processes to eliminate nitrogen and phosphorus from wastewater discharges.*
- *ensure that information about innovative advanced treatment processes and technologies is widely disseminated.*



- *support development of technologies to reduce concentrations of pharmaceuticals, personal care product ingredients, and other biologically active contaminants in wastewater treatment plant discharges.*

### ***Sewer System Overflows***

Combined sewer systems were designed to collect domestic sewage, industrial wastewater, and rainwater runoff or snowmelt in the same pipes. While these systems provided human health benefits at the time they were constructed, they have a major drawback: when total water volumes exceed the system's capacity, the overflow enters receiving waters without treatment. Sanitary sewer systems, which are designed to transport only domestic sewage and industrial wastewater, can also under some circumstances overflow, discharging untreated wastewater.

EPA estimates that at least 40,000 sewers overflow every year, discharging wastewater directly into rivers, estuaries, and oceans. In addition to causing human health problems and closures of beaches and shellfishing areas, human sewage may be a contributing factor in the decline of coral reefs.<sup>11</sup>

### ***Septic Systems***

About 25 percent of the U.S. population is served by residential septic systems and about 33 percent of new homes use these systems.<sup>12</sup> If not properly managed, septic systems can become a significant source of coastal pollution, particularly pathogens and nutrients. Septic systems can contaminate aquifers and coastal waters either by direct overflow from improperly operating systems or by migration of pollutants through groundwater to surface waters. The threat can be severe in places like Florida where the ground is highly permeable and the water table close to the surface. Government policies and subtle socioeconomic factors may be encouraging new development that relies on septic systems rather than centralized wastewater treatment, even in locations where population density would support centralization. To protect coastal waters, it is important to ensure that existing and new septic systems are properly designed, located, constructed, and maintained.

**Recommendation 14–2. The U.S. Environmental Protection Agency (EPA) and states should increase technical and financial assistance to help communities improve the permitting, design, installation, operation, and maintenance of septic systems and other on-site treatment facilities. State and local governments, with assistance from EPA, should adopt more effective building codes and zoning ordinances for septic systems and should improve public education about the benefits of regular maintenance.**

### ***Industrial Facilities***

While some industrial plants are connected to wastewater treatment plants, others discharge directly into receiving waters. Discharges to wastewater treatment plants must comply with certain pretreatment requirements established by the facility operator. Direct discharges must have a National Pollutant Discharge Elimination System permit which establishes limits on pollutants in the effluent. Initially, permits are based on the use of best available technology. However, in cases where the use of best available technology is insufficient to meet water quality standards, further action may be required.

Although the National Pollutant Discharge Elimination System and pretreatment requirements have made significant progress in abating industrial sources of pollution, these sources remain a significant cause of environmental degradation in some areas. Industrial discharges can contain nutrients, mercury, lead, sulfur, oils, corrosives, and other toxic chemicals. Another group of contaminants entering coastal waters from industrial sources is polychlorinated biphenyls (PCBs). Although these compounds are no longer



manufactured and new uses are severely restricted, improper disposal and continued use of older PCB-containing products persist. In many cases, discharges from factories and power plants are also warmer than surrounding waters, resulting in thermal pollution that can disrupt local ecosystems.

### ***Animal Feeding Operations***

Many animal feeding operations are located in coastal areas or in upstream areas that flow into coastal waters; these businesses have become major contributors to coastal water pollution. For example, along the East Coast, many feeding operations are concentrated in the coastal plain, which is home to an economically important and ecologically sensitive network of wetlands, rivers, estuaries, and coastline.

In the United States, approximately 238,000 animal feedlots produce an estimated 500 million tons of manure every year—more than three times the amount of sewage produced by humans.<sup>13</sup> The animal manure generates discharges of solids and liquid effluent to groundwater and surface waters. Ammonia and other gases also volatilize from manure in storage facilities or on fields, resulting in atmospheric transport and deposition of pollutants. Pollutants originating at animal feeding operations include nutrients, ammonia, pathogens, hydrogen sulfide, methane, pesticides, and antibiotics.

Although discharges from animal feeding operations resemble nonpoint sources of pollution, they are regulated as point sources under the National Pollutant Discharge Elimination System program. In particular, facilities designated as concentrated animal feeding operations are subject to specific regulations. By 2006, all concentrated animal feeding operations (about 15,500 nationwide) will be required to obtain National Pollutant Discharge Elimination System permits. This requirement is expected to greatly reduce the amount of nutrients and sediments entering coastal waters.<sup>14,15</sup> States may impose additional requirements such as regulating operations that are not large enough to be regulated by EPA, increased monitoring and reporting standards, and requiring animal processors to be co-permittees along with the contractors raising the animals.

**Recommendation 14–3. Where necessary to meet water quality standards, states should issue regulatory controls on concentrated animal feeding operations in addition to those required by the federal government. The U.S. Environmental Protection Agency and the U.S. Department of Agriculture should fund research on removal of nutrients from animal wastes and should develop improved best management practices that retain animal waste-derived nutrients and pathogens on agricultural lands.**

### **Improving the Control of Point Sources**

To control point source pollution effectively, the nation will need to maintain a long-term commitment to investments in infrastructure, improve the enforcement of water pollution standards, and promote market-based incentives and other innovative approaches.

#### ***The Need for Long-term Infrastructure Investments***

The gap between existing and needed funding for wastewater and drinking water improvements is large, and serious adverse human health and environmental effects are likely if the challenges presented by an aging public infrastructure are not addressed. Capital spending for wastewater treatment infrastructure is currently about \$13 billion per year, and annual operations and maintenance costs are around \$17 billion. EPA estimates that over the next twenty years, the total U.S. need for investment in wastewater treatment infrastructure will exceed \$270 billion, and the need for drinking water infrastructure will reach almost \$265 billion. Sewer system overflows will be particularly costly to correct.<sup>16</sup> In addition, the gap between the

funding states currently have and the funding they will need to fully implement Clean Water Act programs is substantial—about \$700 million to \$1 billion a year—and will most likely increase.<sup>17</sup>

Given expected shortfalls in funding for wastewater-related construction, state revolving loan funds will become even more important. Improving coastal water quality will require long-term financial investments.

**Recommendation 14–4. The U.S. Environmental Protection Agency, working with state and local governments, should develop a prioritized, comprehensive plan for long-term funding of the nation’s current aging and inadequate wastewater and drinking water infrastructure, anticipating demands for increased capacity and more stringent treatment in the coming decades. To implement this plan, Congress should fund the State Revolving Fund Program at or above historic levels.**

*Promoting Market-based Incentives*

One powerful incentive-based approach to reducing water pollution in many watersheds is EPA’s water pollutant trading policy. Under this policy, a source can be reduced beyond required levels, creating a credit that can then be sold to another source discharging the same pollutant to the same body of water. EPA has had a water pollutant trading policy in place since the 1990s, primarily for use between wastewater treatment plants. (EPA’s trading policy does not authorize trading of toxic substances in effluent.)

**Recommendation 14–5. The U.S. Environmental Protection Agency and states should experiment with tradable credits for nutrients and sediments as a water pollution management tool and evaluate the ongoing effectiveness of such programs in reducing water pollution.**

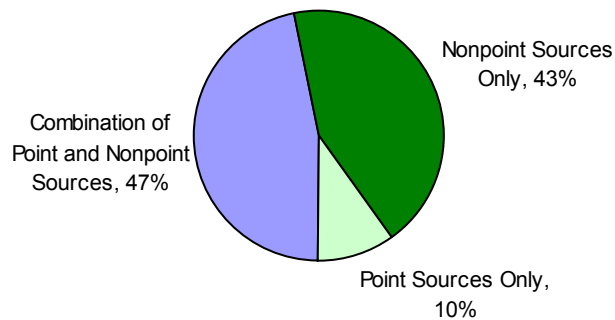
*Improving Enforcement*

Many major point source facilities are exceeding water pollution permit limits. A significant number of the serious offenders are exceeding pollution limits for toxic substances and many violators have been subject to only light penalties or no enforcement at all. In view of this, there is a strong need for improved oversight of states’ permitting and enforcement programs and for more funds and personnel at the state level to properly implement and enforce the National Pollutant Discharge Elimination System program.

**Recommendation 14–6. The U.S. Environmental Protection Agency and states should modernize the National Pollutant Discharge Elimination System’s information management system and strengthen the program’s enforcement to achieve greater compliance with permits and develop an effective ongoing monitoring program.**

## INCREASING THE FOCUS ON NONPOINT SOURCES OF POLLUTION

While considerable progress has been made in reducing point sources of pollution, further progress toward improving coastal water quality will require significant reductions in nonpoint sources as well. This pollution occurs when rainfall and snowmelt carry pollutants over land, into streams and groundwater, and down to coastal waters. Nonpoint source pollutants include: fertilizers and pesticides from rural farms and urban lawns; bacteria and viruses from livestock and pet waste; sediments from improperly managed construction sites and timber harvesting; oil and chemicals flowing over streets, parking lots, and industrial facilities; and a variety of pollutants being blown along airborne pathways. Ninety percent of impaired water bodies do not meet water quality standards at least in part because of nonpoint source pollution (Figure 14.4).

**Figure 14.4. Controlling Nonpoint Source Pollution is Key to Cleaner Waters**

Nonpoint source pollution contributes to 90 percent of all water pollution incidences where water quality is determined to be below the standards set for specific activities such as recreation, water supply, aquatic life, or agriculture. Source: U.S. Environmental Protection Agency. *Clean Water Act Section 303(d) Lists: Overview of TMDL Program*. Washington, DC, 1998.

### Existing Management Tools

Decreasing polluted runoff from agriculture, urban development, and construction will be a significant challenge. Numerous federal agency programs address nonpoint sources of pollution, and some of the most important programs are discussed briefly here. (Appendix D includes additional program information.)

#### *The Total Maximum Daily Load Program*

Many efforts to control nonpoint source pollution are driven by the Total Maximum Daily Load (TMDL) program, administered by EPA as part of the Clean Water Act. A TMDL is the maximum amount of a pollutant, from point and nonpoint sources, that can be present in a water body while still meeting water quality standards. States must develop a TMDL for each pollutant of concern and then implement plans to achieve and maintain those TMDLs by allocating reductions among all sources. To include a margin of safety, states must also take seasonal variations into account.

Because control of point sources has already received so much attention, the TMDL program is shifting its focus to controlling nonpoint sources. As a first step, the program requires states to identify water bodies that are not meeting water quality standards even after all point sources have installed their required pollution control technologies.

Although the TMDL program has been criticized as lacking effective compliance mechanisms for nonpoint source pollution, the program does provide valuable quantitative information on pollution amounts and impacts within a watershed. This information can be used to generate greater public awareness and support for water quality initiatives and to identify the most effective use of funds, such as those available through agricultural conservation programs, to address nonpoint sources within a particular watershed. While TMDLs specify limits for individual pollutants, EPA has been working with states and watershed managers to consider the impacts of multiple pollutants in a larger watershed management context, consistent with comprehensive ecosystem-based management initiatives.

#### *National Nonpoint Source Pollution Program*

Under the National Nonpoint Source Pollution Program, established under Section 319 of the Clean Water Act, EPA provides matching grants to states to develop and implement statewide programs for managing nonpoint sources. Grants may be used for a wide range of activities, including technical and financial

assistance, education and training, monitoring, watershed planning, technology transfer, demonstration projects, and state and local regulatory programs. States must prepare an assessment of waters where the control of nonpoint source pollution is necessary to meet water quality standards, identify the significant sources, and specify control measures. States must also develop a program that sets forth the best management practices necessary to remedy the problems.

### ***Coastal Zone Management Act***

One of the hallmarks of the Coastal Zone Management Act (CZMA) is that it requires each participating coastal state to incorporate the requirements of the Clean Water Act as the water quality portion of the enforceable policies that comprise the state's coastal management program. This provision has proved to be very useful in coordinating these separate federal programs at the state level and should be continued.

In addition, the 1990 amendments to the CZMA created a program specifically to address nonpoint sources of coastal pollution. Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) requires that all states with a federally approved coastal management program to develop a plan that includes enforceable management measures to control nonpoint sources affecting coastal waters. Administration of this program is assigned to both EPA and NOAA to combine their experiences with the Clean Water Act and Coastal Zone Management Act programs. The nonpoint source pollution control program created by Section 6217 relies on implementation of best management practices, compiled by EPA. While modest federal funding has been provided for states to prepare and implement their plans, it has been insufficient to achieve the goals of the CZARA.

### ***U.S. Department of Agriculture Conservation Programs***

Agricultural conservation programs have been growing in importance, scope, and funding. In 2002, Congress dramatically increased funding for these programs, dwarfing the resources of the EPA and NOAA nonpoint programs. The agricultural conservation programs generally involve cash payments to farmers to implement conservation and best management practices on productive farm and ranch lands, retirement of land through permanent or long-term easements, and conservation and restoration of wetlands and grasslands. These programs present an opportunity to decrease nonpoint pollution and improve aquatic habitats and natural resources—the challenge will be to ensure that the programs are targeted to maximize their benefits.

The Environmental Quality Incentives Program—the largest agricultural conservation program—will receive approximately \$5.6 billion in funding through fiscal year 2007. In recent amendments to this program, USDA was directed to reduce nonpoint source pollution in impaired watersheds as one of the nation's most important environmental needs that could be addressed with the help of agricultural producers. The other priorities established for the program—reducing air emissions and soil erosion and promoting habitat conservation—will also have benefits for coastal water quality.

Another important USDA program is the Conservation Security Program, which provides financial and technical assistance to implement stewardship measures. This program is open to any farmer or rancher who wishes to participate, including small operations in coastal areas. It has the potential to improve water quality by encouraging conservation on land in active production and rewarding farmers who have been good stewards but are not able to participate in other conservation programs.

### **Major Nonpoint Sources**

The majority of the nonpoint source pollution entering rivers, estuaries, coastal waters, and ultimately the oceans is from agricultural and stormwater runoff. Stormwater discharges were previously discussed with

respect to municipal wastewater pollution, and they are often classified as point sources. However, they are not as consistent or predictable as industrial or urban wastewater flows and, like other nonpoint pollution sources, are driven primarily by precipitation. Thus, they are discussed here in conjunction with other nonpoint sources.

### ***Agricultural Sources***

There are more than 300 million acres of agricultural land in the United States.<sup>18</sup> Agricultural activities can be a significant source of nonpoint pollution in rivers, lakes, and estuaries and a major contributor to groundwater contamination and wetlands degradation. Soil disturbance, irrigation, and application of herbicides, pesticides, fertilizers, and animal wastes to fields all lead to excess sediments, nutrients, pathogens, and salts in coastal waters.

Excessive sedimentation decreases water clarity, smothers fish spawning areas and coral reefs, and carries pollutants into water bodies. (A more complete discussion of sediment management is provided in Chapter 12.) But arguably the most significant impact from agricultural activities is the transport of nutrients, primarily nitrogen and phosphorous, into coastal waters.

USDA is a very important participant in the nonpoint source management process because of the funding it can provide to address agricultural sources. The state conservationist in each state, an employee of USDA's Natural Resources Conservation Service, is a key player in allocating these funds. State- and county-level committees make recommendations to the state conservationist about best management practices to be rewarded and the appropriate level of cost sharing. There are concerns that funds may still go to farmers and ranchers who follow harmful practices, and many deserving recipients do not receive adequate technical assistance. USDA, the Land Grant Extension Service, Farm Service Agency, and farmers themselves also need to be more closely involved in broader watershed and coastal ecosystem-based management efforts so their actions can be coordinated with the many others that affect coastal water quality.

**Recommendation 14–7. The U.S. Department of Agriculture (USDA) should align its conservation programs and funding with other programs aimed at reducing nonpoint source pollution, such as those of the U.S. Environmental Protection Agency and the National Oceanic and Atmospheric Administration.**

*In particular, USDA's Natural Resources Conservation Service should:*

- *require that its state conservationists coordinate with representatives of federal and state water quality agencies and state coastal management agencies, and participate in watershed and coastal management planning processes, to ensure that funding for agricultural conservation programs complements and advances other federal and state plans.*
- *provide enhanced technical assistance in the field to meet the demands of growing agricultural conservation programs.*

### The Impact of Farm Nutrients on the Marine Environment

Every year, an area covering up to 12,000 square miles in the Gulf of Mexico becomes a dead zone.<sup>19</sup> Nitrogen fertilizers from farms far inland wash into streams and other water bodies and ultimately flow into the Gulf. These nutrients cause excess algal growth, depleting oxygen in the Gulf's bottom waters to levels too low to support fish, crustaceans, and many other forms of marine life.

Over the last half of the 20<sup>th</sup> century, the use of nitrogen fertilizers within the Mississippi River Basin watershed increased exponentially. The main contributors to the Gulf's dead zone are located along the Mississippi and Ohio rivers, in southern Minnesota, Iowa, Illinois, Indiana, and Ohio (Figure 14.5). On average, streams draining from Iowa and Illinois contribute about 35 percent of the nitrogen discharged from the Mississippi River to the Gulf of Mexico.<sup>20</sup>

**Figure 14.5. Pollution Drains from the Midwest to the Louisiana Coast**



The Mississippi–Atchafalaya River Basin (the shaded area in the figure) is the largest river basin in North America, draining an area of 1.24 million square miles or about 41 percent of the continental United States. Polluted waters from the basin flow into the Gulf of Mexico affecting coastal areas. Increased nutrients have resulted in a low oxygen zone along the Louisiana coast.

Source: Committee on Environment and Natural Resources. *Integrated Assessment of Hypoxia in the Northern Gulf of Mexico*. Washington, DC: National Science and Technology Council, 2000.



### ***Urban and Suburban Stormwater Runoff***

Stormwater runoff poses another serious threat to U.S. coastal waters. Housing developments, shopping centers, and roads have been built in areas once covered by natural vegetation and wetlands. These developments have increased impervious surfaces, decreased the land available to absorb rain and snow, accelerated runoff into streams, and altered the hydrology of coastal watersheds. Many areas have lost billions of gallons of drinking water due to reductions in groundwater recharge.<sup>21</sup>

Stormwater picks up a variety of substances on its way to coastal waters, including oil, chemicals, heavy metals, pesticides, trash, and pet waste. These pollutants alter the water chemistry and can harm ecosystems. As water runs across impervious surfaces, its temperature also becomes elevated, accelerating the growth of algae and harming fish and other aquatic life that have specific water temperature tolerance limits. Larger volumes of water rushing into streams also erode streambanks, streambeds, and the surrounding land, transporting excess sediments that can damage coastal habitat, harm aquatic life, and reduce light penetration into the water column.

It is estimated that aquatic ecosystem health becomes seriously impaired when more than 10 percent of the watershed is covered by impervious surfaces.<sup>22</sup> Impervious surfaces cover 25–60 percent of the area in medium-density residential areas, and can exceed 90 percent at strip malls or other commercial sites.<sup>23</sup>

Stormwater-related problems impose measurable economic costs. Drinking water sources can become polluted and excess sediment can increase dredging costs for navigational purposes. Poor stormwater management may increase flooding, causing property damage from flash floods and leading to higher insurance rates. Stormwater is also a source of bacterial contamination, leading to increased disease incidence, thousands of beach closures in the United States each year, and loss of revenues from coastal tourism and sport fishing.<sup>24</sup> Millions of dollars are spent on treating the symptoms of stormwater pollution but much less is spent on efforts to control its causes.

### **Improving the Control of Nonpoint Sources**

The nation has a number of opportunities to reduce the impacts of nonpoint sources of pollution on coastal waters. These include coordination of federal nonpoint programs so they are mutually supportive, more targeted and aggressive use of state revolving loan funds, broader implementation of incentives and disincentives, and improved monitoring to assess compliance and overall progress. State and local governments also have important roles to play in land use planning and stormwater management decisions.

#### ***Aligning Federal Nonpoint Programs and Goals***

The management of nonpoint source pollution in coastal areas includes a mix of planning requirements, state actions, direct funding incentives, and grant programs to encourage standard setting and implementation. Some programs are directed by EPA; one is jointly directed by NOAA and EPA; USDA and USACE both have programs with substantial impacts; and state and local governments play major roles. Currently, there is no mechanism to ensure that the diverse programs are effective, are being adequately coordinated, and are working toward common goals. Addressing nonpoint source pollution will require mechanisms at both the national and regional levels to develop goals and coordinate efforts to meet those goals.

**Recommendation 14–8.** The National Ocean Council (NOC) should establish significant reduction of nonpoint source pollution in all impaired coastal watersheds as a national goal, and set specific, measurable objectives focused on meeting human health- and ecosystem-based water quality standards. The NOC should ensure that all federal nonpoint source pollution programs are coordinated to meet those objectives.



Coordination among the many agencies, however, will not be enough. States must have enforceable policies, similar to those called for in the CZARA Section 6217 nonpoint source pollution control program, but with greater funding and incentives to reward states that adopt proactive nonpoint source control programs, such as are provided under the Clean Water Act Section 319 program. These programs both have positive attributes that, if combined, could more effectively address nonpoint source pollution. A combination of incentives and enforcement techniques will be needed to ensure progress.

**Recommendation 14–9. To improve and strengthen federal efforts to address nonpoint source pollution, Congress should amend the Clean Water Act to merge the National Oceanic and Atmospheric Administration’s enforceable nonpoint source pollution program, created under Section 6217 of the Coastal Zone Act Reauthorization Amendments, into the U.S. Environmental Protection Agency’s incentive-based program, created under Section 319 of the Clean Water Act. To support these efforts, Congress should provide adequate federal resources to enable states to implement best management practices.**

#### *Expanding Uses of State Revolving Loan Funds*

Currently, the State Revolving Loan Funds are primarily used for addressing municipal point source pollution, but they have also been tapped to address nonpoint sources by funding watershed-based activities, including control of agricultural and urban runoff. Because of the large funding gap in wastewater infrastructure needs, loan funds will need to be supplemented to meet these new demands (see Recommendation 14-4.)

#### *Creating Incentives to Reduce Agricultural Runoff*

Because of the many individuals involved, and their geographic and socioeconomic diversity, an incentive-based strategy may be a good approach for reducing pollution from agricultural sources. A number of agricultural conservation programs (some of which are described above) provide incentives to farmers and ranchers to set aside areas of land, purchase better equipment, and employ best management practices.

Several additional forms of incentives could encourage farmers and ranchers to follow practices that would reduce nonpoint source pollution. Some examples include the following:

- Congress and USDA could develop incentives to reward farmers and ranchers by providing special services or technology for good performers.
- Congress could enact tax incentives for farmers and ranchers who implement best management practices that reduce nutrient and soil runoff.
- Congress and USDA could establish insurance programs for agricultural producers who apply fertilizer at or below the agronomic rates recommended by the local Land Grant University to compensate the producers if crop yields decrease as a result.
- Federal farm aid could be tied to implementation of best management practices to reduce nonpoint source pollution.

Efforts to reduce nonpoint source pollution through incentives are already underway. For example, the Sand County Foundation launched a pilot program to test market-based incentives for reducing nitrogen discharges from agricultural lands in targeted watersheds in the Upper Midwest and to gauge farmers’ receptiveness to such incentives.

Other kinds of market-based programs would allow farmers to create nutrient credits by changing cropping practices or implementing best management practices. These credits could then be sold to a wastewater

treatment plant or other nutrient source discharging to the same water body to offset some of its own nutrient outflow and help meet water quality limits.

### ***Authorizing Federal Agencies to Impose Disincentives***

While the use of incentives has many benefits, the federal government must take action when a state is failing to protect water quality. Existing nonpoint source programs do not include the necessary federal authority to do so. For example, the Clean Water Act does not authorize EPA to develop and implement management plans, best management practices, or other nonpoint source control measures if state efforts are failing. As a result, EPA's only recourse is to withhold grant funds, depriving a struggling state of critical funding that is already too limited to successfully address nonpoint source problems.

A similar problem exists in the CZARA Section 6217 nonpoint source pollution control program, where the emphasis has been on crafting programs, with less focus on implementation. If a state fails to implement the management measures in its plan, the only recourse for EPA and NOAA is to withhold Clean Water Act and Coastal Zone Management Act grant funds. The potential loss of Clean Water Act funds could more than offset potential gains from CZARA funding, creating a disincentive to participate in the CZARA process at all. To avoid this result and encourage states to participate, EPA and NOAA have postponed deadlines and relaxed oversight, introducing uncertainties that hinder good long-term planning.

In the end, if a state continues to fail in controlling nonpoint source pollution, the federal government should step in to protect the public resource. In addition to invoking regulatory authority, the federal government may have to apply financial disincentives. Reasonable disincentives might include withholding federal funds for programs that contribute to degradation of water quality, such as federal highway construction, agricultural subsidy programs, or USACE development projects in watersheds that are impaired. Funding for federal programs that *promote* water quality should be maintained to encourage continued progress.

Federal regulatory action and financial disincentives to protect water quality should only be invoked if a state chronically fails to make meaningful progress toward controlling nonpoint sources, similar to the precedent established for similar situations under the Clean Air Act. In other words, the federal government should take the lead when all else fails. Federal regulatory authority and financial disincentives should be phased in over time and should be predictable and clearly communicated. Additionally, the standards for triggering federal financial disincentives or regulatory involvement should be designed with care and should consider mitigating circumstances such as whether the failure to attain water quality standards in a state is due to water quality problems that originate in upstream states.

**Recommendation 14–10. Congress should provide authority under the Clean Water Act and other applicable laws for federal agencies to impose financial disincentives and establish enforceable management measures to ensure action if a state does not make meaningful progress toward meeting water quality standards on its own.**

### ***Monitoring to Assess Compliance***

After best management practices are employed and incentive programs are underway, ongoing monitoring will be essential to determine whether these efforts have been effective. A detailed discussion of water quality monitoring is provided in Chapter 15.

### ***Thinking about Land Use***

Land use decisions dramatically affect the health of coastal waters. The siting and design of new development must consider such potential impacts and balance them with socioeconomic factors. Many local zoning

ordinances and building codes actually pose significant barriers to low-impact development approaches. For example, ordinances that control the design of curbs, gutters, and streets can reduce or exacerbate the need for stormwater management measures. In addition to its positive impacts on water quality, low-impact development can bring economic advantages. For example, developers are often able to realize additional profits and quicker sales on units that are adjacent to a landscaped stormwater control structure such as a constructed wetland.

Greater public awareness of the connection between land use and water quality will help move decision makers in the right direction. One program that provides education on the effects of planning, zoning, and land use decisions on water quality is Project NEMO—Nonpoint Education for Municipal Officials. Project NEMO is a University of Connecticut program supported by many different partners including EPA, NOAA, USDA, the National Aeronautics and Space Administration, and the U.S. Fish and Wildlife Service. While this program has had successes, it only reaches a small fraction of the tens of thousands of relevant decision makers across the nation.

**Recommendation 14–11. State and local governments should revise their codes and ordinances to require land use planning and decision-making to carefully consider the individual and cumulative impacts of development on water quality, including effects on stormwater runoff. The U.S. Environmental Protection Agency and other appropriate entities should increase outreach programs that provide local land use decision makers with the knowledge and tools needed to make sound land use decisions that protect coastal water quality.**

### *Managing Stormwater Runoff*

The primary method for controlling stormwater runoff is the application of best management practices. Structural best management practices are measures—such as constructing detention basins, wet ponds, or wetlands—that help control the quantity and quality of stormwater. Nonstructural best management practices are generally preventive actions that rely on behavioral changes, such as modifying the use of fertilizers, sweeping streets, and educating the public. EPA and the American Society of Civil Engineers have jointly developed a national database of stormwater best management practices as a tool for local stormwater designers and planners.

While best management practices can be effective, these tools may not be sufficient on their own. In urban areas, construction activities still contribute significantly to sediment loadings and, where impervious surfaces are prevalent, stormwater flows directly into surface waters and sewer systems. A comprehensive approach will be required to minimize disturbance to the natural hydrology, minimize water flow over surfaces, and maintain water quality. Rigorous monitoring will also be needed to determine whether water quality standards are being achieved and to allow management approaches to be modified as needed to reach desired water quality goals.

**Recommendation 14–12. The U.S. Environmental Protection Agency, working with state and local governments, should ensure that stormwater management programs are based on a comprehensive approach that includes: codes or ordinances requiring best management practices; increased enforcement of legal requirements; monitoring to determine whether goals and state water quality standards are being met and to identify ongoing problems; an adaptive management approach to ensure that efforts are effective and that best management practices are modified as needed; improved public education; and funding and personnel sufficient to implement and enforce stormwater management programs.**

## Collaboration at the Watershed Scale

As discussed in Chapter 9, watersheds are often the appropriate geographic unit for addressing water-related problems because they acknowledge upstream and downstream connections and consider the cumulative impacts of activities taking place in the watershed. These features are particularly important in addressing nonpoint source pollution.

Collaborative watershed groups have had significant successes in addressing nonpoint source pollution. These groups bring together stakeholders reflecting the diverse interests that may be represented in a watershed: agriculture, timber, and industry; sport and commercial fishing interests; recreational users and tourism-related businesses; environmental and citizen groups; and local, state, tribal, and federal governments. While such public/private sector collaborations can complement more traditional water pollution control strategies, they are often hampered by limited financial resources, institutional instability, and lack of technical expertise.

Addressing nonpoint source pollution on a watershed basis makes good sense for environmental, financial, social, and administrative reasons. In addition, regional ocean councils can play an important role in helping to support the collaborative efforts of watershed groups. Collaborative watershed approaches can build a sense of community, reduce conflicts, increase commitment to the actions necessary to meet common goals and, ultimately, improve the likelihood of sustaining long-term water quality improvements.

**Recommendation 14-13. The National Ocean Council and regional ocean councils should strengthen the ability of collaborative watershed groups to address problems associated with nonpoint source pollution by developing and implementing strategies to provide them with adequate technical, institutional, and financial support.**

## International Efforts

Nonpoint source pollution is an important, and increasingly visible, international issue. The health, well-being and, in some cases, the very survival of coastal populations around the world depend upon the viability of coastal and marine systems. Nonpoint source pollution threatens these areas and the important economic activities, such as fishing and tourism that they support. Public health is also adversely affected through contamination of seafood, direct contact, such as through bathing, and the use of seawater in desalination and food-processing plants.

Ongoing efforts to reduce nonpoint source pollution internationally include the United Nations Environment Program's (UNEP's) establishment of fourteen regional seas programs worldwide as part of the 1995 Global Program of Action for the Protection of the Marine Environment from Land-Based Sources (GPA). Many nations, including the United States, are moving forward with initiatives to implement the GPA. However, broader application of GPA measures will depend on increased foreign technical assistance and funding. The U.S. Agency for International Development, NOAA, and EPA provide limited technical and training assistance through UNEP for nations where sewage treatment, monitoring, research, and law enforcement capacity are insufficient.

As part of the GPA, UNEP launched the Hilltops to Oceans initiative (H2O) at the 2002 World Summit on Sustainable Development. Overall objectives of H2O include facilitating international recognition of the links between freshwater and marine environments and assisting in the implementation of actions needed to reduce, remediate, and prevent pollution and degradation of the coastal and marine environment.

The United States is particularly involved in the coordination, integration, and management of marine pollution programs in the wider Caribbean region, including programs for addressing upstream sources and protecting wetlands, mangrove swamps, coral reefs, and offshore areas. At the 2002 Summit, the United

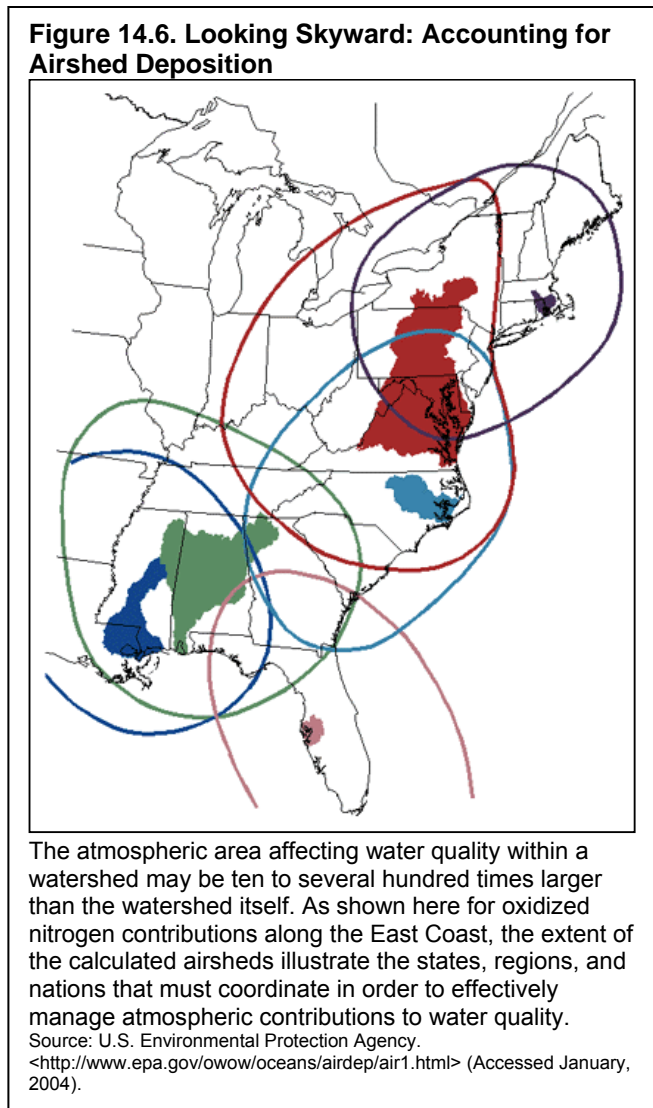
States launched the White Water to Blue Water initiative with a coalition of partners that includes the United Kingdom, France, Canada, the Netherlands, Caribbean island governments, nongovernmental organizations, and the private sector. The ultimate goal of the initiative is to improve the capabilities of all coastal nations to manage watershed and coastal ecosystems for sustainable development. Participants hope that success in implementing the pilot phase in the Caribbean will encourage other regions in Africa and the South Pacific to follow suit.

## ADDRESSING ATMOSPHERIC SOURCES OF POLLUTION

Atmospheric deposition of pollutants can also harm water quality, aquatic resources, and human health. Atmospheric deposition accounts for between 10 and 50 percent of the nitrogen entering estuaries along the U.S. East Coast and the Gulf of Mexico.<sup>25, 26</sup> Major atmospheric pollutants include nutrients, metals such as lead and mercury, pesticides, polycyclic aromatic hydrocarbons, dioxins, furans, and persistent toxic substances. Certain persistent toxins, such as DDT and PCB, have even been measured in remote locations, such as the Arctic and Antarctic, demonstrating the extent of dispersal of pollutants by the atmosphere. Atmospheric deposition is also a significant source of pollution in the Great Lakes; as much as 90 percent of some toxic chemicals entering the Great Lakes are believed to be the result of atmospheric deposition.<sup>27</sup> Sources of atmospheric deposition are quite varied and include agriculture, incineration, coal-fired power plants, industrial facilities, and motor vehicles, as well as natural sources such as forest fires, lightning, and volcanoes.

### Improving Control of Atmospheric Sources

Addressing atmospheric deposition requires controlling multiple sources within a particular waterbody's airshed, defined as the geographic area responsible for 75 percent of the air pollutants that reach that body of water (Figure 14.6). The airshed can be ten, twenty, or even several hundred times larger than the area of the watershed.



To add to the complexity, different pollutants exhibit different physical and chemical behaviors in the atmosphere, so the airshed of a particular body of water may vary depending on the pollutant of interest. The federal government is taking some positive steps to address atmospheric deposition. For example, in 2001



EPA developed the Air-Water Interface Work Plan, detailing actions that the agency can take based on authorities in the Clean Air and Clean Water Acts.

**Recommendation 14–14. The U.S. Environmental Protection Agency, states, and watershed groups should explore regional approaches for managing atmospheric deposition, particularly when it affects water bodies in states far from the source.**

Control of atmospheric deposition is currently hampered by relatively poor data on sources, atmospheric transport routes, and the sites where pollutants are ultimately deposited. While several monitoring programs exist, relatively few are in coastal areas. Reducing atmospheric deposition would be greatly aided by better data, analysis, and information on emission sources, fate and transport, and related environmental and human health consequences. (A further discussion of monitoring needs is provided in Chapter 15.)

Because of the potential range of atmospheric dispersion, international cooperation will also be needed. One example of an issue requiring urgent international action is mercury contamination in fish, a human health concern because of potential neurotoxic effects, particularly for pregnant women and children. International action to control persistent organic pollutants and other toxic substances is carried out under UNEP programs implementing the Stockholm Convention on Persistent Organic Pollutants.

<sup>1</sup> U.S. Environmental Protection Agency. *National Water Quality Inventory: 2000 Report*. EPA-841-R-02-001. Washington, DC, August 2002.

<sup>2</sup> National Research Council. *Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution*. Washington, DC: National Academy Press, 2000.

<sup>3</sup> Rabalais, N. N., and S. W. Nixon. "Preface: Nutrient Over-enrichment of the Coastal Zone." *Estuaries* 25, no. 4B (August 2002): 639.

<sup>4</sup> National Research Council. *Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution*. Washington, DC: National Academy Press, 2000.

<sup>5</sup> Bricker, S.B., et al. *National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries*. Silver Spring, MD: National Oceanic and Atmospheric Administration, September 1999.

<sup>6</sup> U.S. Environmental Protection Agency. "Clean Water State Revolving Fund." <<http://www.epa.gov/owm/cwfinance/cwsrf/index.htm>> Accessed May 30, 2003.

<sup>7</sup> National Research Council. *Managing Wastewater in Coastal Urban Areas*. Washington, DC: National Academy Press, 1993.

<sup>8</sup> U.S. Environmental Protection Agency. "National Estuary Program Successes." <<http://www.epa.gov/owow/estuaries/success.htm>> Accessed October 27, 2003.

<sup>9</sup> Atkinson, S., M.J. Atkinson., and A.M. Tarrant. "Estrogens from Sewage in Coastal Marine Environments." *Environmental Health Perspectives* 111, no. 4 (2003): 531–35.

<sup>10</sup> Harries, J.E., et al. "A Survey of Estrogenic Activity in United Kingdom Inland Waters." *Environmental Toxicology and Chemistry* 15 (1996): 1993–2002.

<sup>11</sup> Potera, C. "Is Sewage Destroying Coral?" *Environmental Health Perspectives* 111, no. 4 (April 2003): A207.

<sup>12</sup> U.S. Environmental Protection Agency. *Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*. EPA 832-B-03-001. Washington, DC, March 2003.

<sup>13</sup> U.S. Environmental Protection Agency. "National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal Feeding Operations (CAFOs): Final Rule." *Federal Register* 68 (February 12, 2003): 7175 et seq.

<sup>14</sup> *Ibid.*, 7176, 7239.

<sup>15</sup> U.S. Environmental Protection Agency, "EPA and Agriculture Working Together to Improve America's Waters." <[http://epa.gov/epahome/headline\\_121602.htm](http://epa.gov/epahome/headline_121602.htm)> Posted December 16, 2002; Accessed October 27, 2003.

<sup>16</sup> U.S. Environmental Protection Agency. *The Clean Water and Drinking Water Infrastructure Gap Analysis*. EPA 816-R-02-020. Washington, DC, September 2002.

<sup>17</sup> EPA–State Task Force. *State Water Quality Management Resource Analysis: Interim Report on Results*. Washington, DC: U.S. Environmental Protection Agency, April 2002.

<sup>18</sup> U.S. Environmental Protection Agency. *Managing Nonpoint Source Pollution from Agriculture, Pointer No. 6*. EPA 841-F-96-004F. Washington, DC, 1996.

<sup>19</sup> Boesch, D.F., et al. *Marine Pollution in the United States: Significant Accomplishments, Future Challenges*. Arlington, VA: Pew Oceans Commission, 2001.

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- <sup>20</sup> Goolsby, D.A., et al. *Flux and Sources of Nutrients in the Mississippi–Atchafalaya River Basin: Topic 3 Report for the Integrated Assessment of Hypoxia in the Gulf of Mexico*. NOAA Coastal Ocean Program Decision Analysis Series No. 17. Silver Spring, MD: National Oceanic and Atmospheric Administration, Coastal Ocean Office, 1999.
- <sup>21</sup> American Rivers, Natural Resources Defense Council, and Smart Growth America. *Paving Our Way to Water Shortages: How Sprawl Aggravates the Effects of Drought*. Washington, DC, 2002.
- <sup>22</sup> Holland, A.F., et al. "Linkages between Tidal Creek Ecosystems and the Landscape and Demographic Attributes of Their Watersheds." *Journal of Experimental Marine Biology and Ecology*. In press.
- <sup>23</sup> Natural Resources Defense Council. "The Causes of Urban Stormwater Pollution." In *Stormwater Strategies*. Washington, DC, 1999.
- <sup>24</sup> Chasis, S., and M. Dorfman. *Testing the Waters: A Guide to Water Quality at Vacation Beaches*. Washington, DC: Natural Resources Defense Council, 2000.
- <sup>25</sup> Valigura, R.A., et al., eds. *Nitrogen Loading in Coastal Water Bodies: An Atmospheric Perspective*. Coastal and Estuarine Studies No. 57. Washington, DC: American Geophysical Union, 2000.
- <sup>26</sup> Valigura, R.A., et al. *Atmospheric Nutrient Inputs to Coastal Areas: Reducing the Uncertainties*. NOAA Coastal Ocean Program Decision Analysis Series No. 9. Silver Spring, MD: National Oceanic and Atmospheric Administration, 1996.
- <sup>27</sup> Great Lakes Information Network. "Atmospheric Deposition in the Great Lakes Region." <<http://www.great-lakes.net/envt/air-land/airdep.html>> Accessed October 28, 2003.



**CHAPTER 15:****CREATING A NATIONAL WATER QUALITY MONITORING NETWORK**

*Ongoing monitoring is essential to assess the health of ocean and coastal ecosystems and detect changes over time. More than any other measure, monitoring provides accountability for management actions. The nation needs a coordinated, comprehensive water quality monitoring network that can provide the information necessary for managers to make informed decisions, adapt their actions as needed, and assure effective stewardship of public resources. In developing such a network, the National Oceanic and Atmospheric Administration, the U.S. Environmental Protection Agency, the U.S. Geological Survey, and other federal agencies as appropriate, should collaborate to ensure adequate monitoring in coastal areas and the upland regions that affect them. Input from states, territories, tribes, counties, and communities—where much of the monitoring will be conducted—is also essential. In addition, because of the inherent overlap among inland, coastal, and open-ocean monitoring and observing, the national water quality monitoring network should be closely linked with the Integrated Ocean Observing System and, ultimately, incorporated into a broad Earth observing system.*

**RECOGNIZING THE VALUE OF WATER QUALITY MONITORING**

Pollution of the nation's coastal waters has led to beach closures, oxygen depletion, health impacts from toxic contamination, and many other problems described in Chapter 14. Despite these threats to coastal waters, there is no national network in place to monitor water quality changes and their causes, facilitate estimates of their economic impact, and measure the success of management efforts. Increased monitoring is needed not only along the nation's coasts, but also inland where pollutants make their way downstream, ultimately impacting coastal waters. A national water quality monitoring network is essential to support the move toward an ecosystem-based management approach that considers human activities, their benefits, and their potential impacts within the context of the broader biological and physical environment. While current water quality monitoring helps track specific substances, it has been less effective in helping understand how various ecosystem components interact and change over the long term.

Monitoring information will be useful to many people including beachgoers, fishermen, scientists, water providers, and others. Coastal managers need to understand the scope of the problems they are facing before they can effectively respond. After responding, monitoring information will also help assess the effectiveness of the selected management approaches.

An essential step toward controlling pollution will be to strengthen and coordinate monitoring efforts. Questions have been raised about the comparability and accuracy of information produced by disparate monitoring programs and about the practical value of the information to stakeholders. Federal and state agencies around the country will need to work closely together to achieve a fully effective national system.

## **MONITORING AT THE FEDERAL LEVEL**

A number of monitoring efforts are currently conducted by federal agencies, state governments, research institutions and academia, nongovernmental organizations, and individual volunteers. Existing monitoring programs vary in many respects, including sampling design and intensity, parameters tested, analytical methodology, data management protocols, and funding. Even when the same properties are measured, different data management protocols may make the integration of that information difficult. Consequently, while a number of monitoring programs exist, they are not designed to support a comprehensive and coordinated national monitoring network. To make matters worse, budget constraints have resulted in significant reductions in monitoring of coastal areas.

Responsibility for monitoring and assessing natural resources is divided among a number of agencies whose activities are focused on achieving specific programmatic objectives or agency missions.

### **Federal Programs**

The main federal agencies involved in water quality monitoring include the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), and the U.S. Environmental Protection Agency (EPA). The U.S. Department of Agriculture (USDA) and the U.S. Army Corps of Engineers also conduct some limited monitoring.

The mission of NOAA's National Status and Trends program is to determine the status of, and detect changes in, the environmental quality of the nation's estuarine and coastal waters. The program conducts long-term monitoring of contaminants and other environmental conditions at approximately 280 sites. In addition, within NOAA's National Estuarine Research Reserve System, a monitoring program was designed to support state-specific, nonpoint source pollution control programs and to develop a nationwide database of environmental conditions in estuaries.

USGS operates the National Streamflow Information Program, a network of about 7,000 stream gages nationwide. About 6,000 of these stations are linked to an Earth-satellite-based communications system. The majority of the stream-gaging stations are jointly funded in partnerships with more than 800 state, local, and tribal governments or other federal agencies. The data are available in real time to conduct water resource projects and for NOAA's National Weather Service to forecast floods. Streamflow data are needed at many sites on a daily basis for forecasting flow extremes, assessing current water availability, and managing water quality and quantity. In addition, USGS conducts long-term water quality and quantity monitoring through the National Stream Quality Accounting Network at fixed locations on large rivers around the country. USGS also operates the National Water Quality Assessment, which uses a regional focus to study status and trends in water, sediment, and biota in forty-two major river basins and aquifer systems. This effort has made considerable progress toward assessing current water quality conditions and long-term trends.

EPA's Environmental Monitoring and Assessment Program aims to develop the tools and science needed for a state-based statistical monitoring framework to determine trends in the condition of all the nation's aquatic ecosystems. This program uses a probabilistic sampling design that relies on data from many sites of similar habitat type as the best estimate for overall condition of that habitat. A variety of information is collected through this program, including water column parameters, sediment chemistry and toxicity, and measurements of benthic communities. While the program provides the benefits of a probabilistic approach, the design is not as well suited for trend analysis. EPA also conducts monitoring through its National Estuary Program. As National Estuary Program sites were created, they included an extensive characterization phase and an estuary-specific monitoring plan. Although most continue monitoring to evaluate the effectiveness of their implementation efforts, there is no program-wide monitoring strategy. Finally, EPA is authorized to

support microbiological testing and monitoring of coastal recreational waters through the Beaches Environmental Assessment and Coastal Health Act, which was designed to reduce the risk of disease to users of the nation's coastal recreational waters.

Several agencies monitor atmospheric deposition, the process by which chemicals in the air are deposited onto the Earth's surface in wet and dry forms, which contributes significantly to coastal water pollution. The National Atmospheric Deposition Program, a cooperative effort of many different groups, measures deposition of a number of pollutants at more than 200 sites. The Mercury Deposition Network, one component of this program, measures mercury levels in wet deposition. EPA's Clean Air Status and Trends Network also measures dry deposition at about eighty sites.

### **Shortcomings in Federal Programs**

Despite the existence of the many programs described above, their combined efforts do not constitute a comprehensive, coordinated water quality monitoring network. One severe limitation of current efforts is the lack of monitoring in coastal waters.

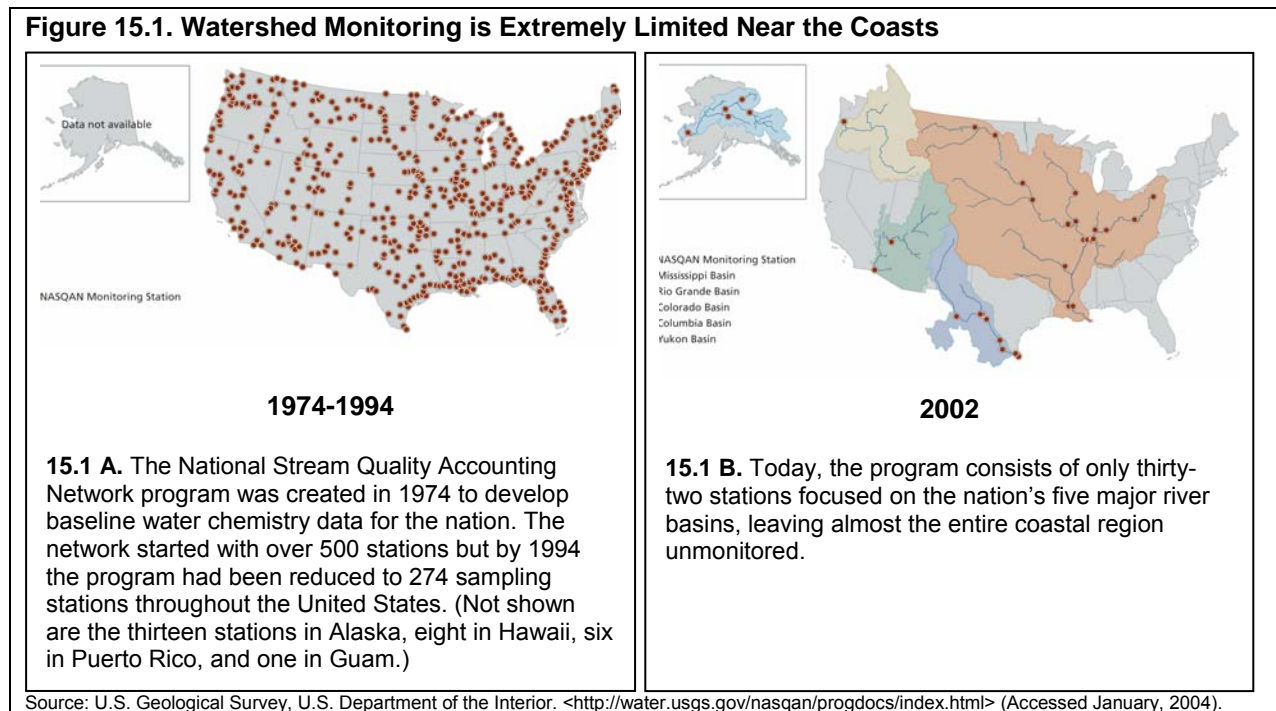
National monitoring has been greatly reduced, particularly in coastal areas, due to funding cuts at USGS and many partner agencies. The USGS National Streamflow Information Program has eliminated a number of stream gages, including long-term gages that are critical for studying climate change. To fully realize its potential, the stream-gaging network needs to be modernized and gaps in coverage filled. Funding cuts have also affected USGS's water quality monitoring programs, resulting in reductions in the number of sampling sites and sampling frequency. USGS's National Water Quality Assessment's coverage has also been reduced in recent years, leaving out much of the coastal region. A 2001 National Research Council report concluded that while this program has downsized in a logical manner, they cannot continue to downsize and still be considered a national program for assessing water quality.<sup>1</sup>

Budget constraints have also affected the National Stream Quality Accounting Network. At its peak in 1978, this program included 520 fixed-station sampling sites on moderate and large rivers, which provided monthly estimates of flow rates, suspended sediment, nutrients, trace metals, indicator bacteria, and phytoplankton. About 140 of the sites were located in areas helpful to estimating the input of water and materials to estuaries. Currently, this program focuses only on monitoring the water quality of the nation's largest rivers—the Mississippi, Columbia, Colorado, Rio Grande, and Yukon—with a total of only thirty-two stations. Most coastal regions are left out of the monitoring network altogether (Figure 15.1).

NOAA's National Status and Trends Program is limited by the number of sites sampled per state and the lack of full representation of estuarine habitats in those states. The program samples mollusks for contaminants only every other year, and even less frequently for sediments.

Of the more than 200 sites in the National Atmospheric Deposition Program, very few are located in coastal areas. Less than 20 percent of sites in the Atmospheric Integrated Research and Monitoring Network, a sub-network of the National Atmospheric Deposition Program, are located in coastal areas.

**Figure 15.1. Watershed Monitoring is Extremely Limited Near the Coasts**



Much of the monitoring in the United States is conducted by states, territories, nongovernmental organizations, and volunteers. There is considerable variation in the ways states select monitoring sites, the kinds of tests they perform, the methods they use to determine causes and sources of pollution, and the analytical approaches they choose to evaluate water quality. As a result, reports on the quality of a particular water body often differ on either side of a state line. These disparities diminish the usefulness of state monitoring programs for regional or national assessments. To be fully effective, the monitoring data collected by states, territories, nongovernmental organizations, and volunteers should be coordinated with a national monitoring network.

## PROMOTING INTERAGENCY COORDINATION

Several interagency initiatives have been proposed for achieving a more coordinated monitoring strategy. The Intergovernmental Task Force on Monitoring Water Quality was established in 1992 to review national water quality monitoring activities and to develop an integrated national monitoring strategy. Chaired by EPA, with USGS as vice chair, the task force recommended, among other things, the development of closer working relationships among organizations that monitor and use water information and the development of comparable technical methods.<sup>2</sup>

The National Water Quality Monitoring Council was formed in 1997 as the successor to the task force, with the mandate to implement the task force's strategy. Jointly chaired by EPA and USGS, the council is composed of thirty-five representatives from federal, state, tribal, local, and municipal governments, watershed groups, academia, and the private sector. The council serves as the major national forum for the coordination of consistent and scientifically defensible federal and state water quality monitoring methods and strategies. Its focus has been on fresh water monitoring, but many of the methods it has developed could also be applied to marine environments.

The National Science and Technology Council's Committee on Environment and Natural Resources has also promoted an initiative to integrate and coordinate environmental monitoring efforts. From this initiative came the 1997 report, *Integrating the Nation's Environmental Monitoring and Research Networks and Programs: A Proposed Framework*. The framework is designed to produce the necessary scientific data and information to produce integrated environmental assessments.

The Coastal Research and Monitoring Strategy Workgroup was formed in 1999 with representatives from federal, state, tribal, and nongovernmental organizations. NOAA, EPA, USGS, and USDA led the development of the workgroup's Coastal Research and Monitoring Strategy, published in 2000, which called for addressing problems of coastal water quality and coastal resources by replacing single-issue, single-agency, single-discipline problem solving with a coordinated, multi-agency, interdisciplinary approach.

While these interagency initiatives are moving in the right direction, they have not resulted in the comprehensive and coordinated national monitoring network resource managers need, particularly in coastal areas. Significant obstacles include a lack of focus on the coast, the absence of some agencies with relevant responsibilities, inadequate follow-through, and a lack of commitment at the highest levels of government.

## ENSURING COMPREHENSIVE, COORDINATED COVERAGE

The nation's coastal margin is the most densely populated and developed region of the nation, and its waters have been significantly degraded by pollution. Yet in recent years, due largely to lack of funding, monitoring has been extremely sparse along the coasts. Much remains unknown about the status of coastal waters, and increased monitoring will be required to make informed management decisions about this economically and ecologically valuable region. Yet the close connections between coastal and upstream waters dictate that any water quality monitoring network must be national in scope. Despite decades of monitoring efforts by many agencies, the nation still lacks such a national network.

Because of the inherent overlap between inland, coastal, and open-ocean monitoring and observing, the national water quality monitoring network should be closely linked with the Integrated Ocean Observing System (IOOS; discussed in detail in Chapter 26) and ultimately with a broad Earth observing system. The national water quality monitoring network will provide the capability to observe, analyze, and forecast natural and human-induced changes that affect waters from inland out to the estuaries and coasts. The IOOS will provide the nation with similar information for the coasts and open-ocean environments. Because these systems will overlap in coastal areas, they should be closely coordinated to ensure compatibility of information. At some point, the national water quality monitoring network and the IOOS should both become components of a true Earth observing system that links land, air, and water around the globe.

**Recommendation 15-1.** The National Oceanic and Atmospheric Administration, U.S. Geological Survey, and U.S. Environmental Protection Agency, working with other appropriate entities, should develop a national water quality monitoring network that coordinates existing and planned monitoring efforts, including monitoring of atmospheric deposition. The network should include a federally funded backbone of critical stations and measurements needed to assess long-term water quality trends and conditions.

**Recommendation 15-2.** The National Oceanic and Atmospheric Administration should ensure that the national water quality monitoring network includes adequate coverage in both coastal areas and the upland areas that affect them, and that the network is linked to the Integrated Ocean Observing System, to be incorporated eventually into a comprehensive Earth observing system.



## **CREATING AN EFFECTIVE MONITORING NETWORK**

In addition to coordinating existing monitoring efforts, an effective national water quality monitoring network should have specific goals and objectives, reflect user needs, and be helpful in assessing the effectiveness of management approaches. The overall system design should determine what and where to monitor, including definition of a set of core variables. Technical expertise will be needed to standardize procedures and establish quality control and data management protocols. The national monitoring network should be periodically assessed and modified as necessary. Most important, the data collected through the national monitoring network should be useful to managers and stakeholders in evaluating management measures, determining best management practices, and making continual improvements in reaching ecosystem goals. The design and implementation of the national monitoring network will require not only federal coordination, but also significant input from the states.

### **System Goals and Objectives**

The national monitoring network should set clear, limited goals and objectives that reflect national, state, regional, territorial, tribal, and local needs. The goals and objectives should be geared toward the assessment of management approaches, including best management practices, and be based on pressing management issues. Successful monitoring should target issues that policy makers, scientists, managers, and the public consider important, providing a basis for possible management actions. Thus, in designing a coordinated national water quality monitoring network, input will be needed from all of these sectors. However, attempts to be everything to everybody will result in an unfocused and ultimately unsuccessful program. Monitoring results should support adaptive management, allowing decision makers to support approaches that demonstrate measurable success in attaining watershed goals and revise practices that are falling short of achieving those goals.

### **System Design**

Sampling protocols are central to the design of an effective national water quality monitoring network. Because regular sampling of all waters for all contaminants would be unacceptably costly, only a subset of the nation's waters can be monitored. The network's designers should determine what, where, and how often to sample, examining existing monitoring systems at the federal, state, territorial, tribal, local, and private levels to determine gaps. Designers should agree on a set of core variables to be measured at every station, with flexibility for stakeholders to measure additional variables if desired.

A national monitoring network should incorporate various types of measurements, including a broad-scale census of fundamental properties, issue- and resource-specific surveys, and intensive monitoring at higher resolution to support the scientific study of ecosystem processes. The network should include both effects-based monitoring, which measures the current condition of the environment, and stressor-oriented monitoring, which measures parameters that are known or suspected to be associated with a decline in environmental health. In addition, the network should combine probabilistic sampling, which allows for statistically valid assessments of water quality conditions in monitored and unmonitored waters, with fixed-station sampling, which samples fixed areas repeatedly over an extended period of time.

### **Technical Coordination**

The monitoring system should include standardized procedures and techniques. Quality assurance and quality control guidelines should be established so that management approaches can be assessed on comparable terms. Data management protocols should be established and uniform data storage formats specified so data

can be broadly disseminated and easily accessed and understood by agency personnel, the scientific and management communities, and the general public.

### Periodic Review and Modification

The monitoring network's design should be evaluated periodically to make sure it is measuring variables that are useful for assessing the health of an ecosystem, to add new variables when necessary, and to make any other changes that would improve the monitoring network. While establishing and standardizing a core set of measurements is important, it is also critical to review this core set periodically to ensure that new substances are added as needed. As new chemicals are detected in the environment and wildlife, their toxicological significance should be assessed and they should be considered as possible additions to the suite of routinely monitored compounds.

#### Keeping Up With New Contaminants

The nature of chemical detection and measurement rarely permits identification of every chemical within an environmental sample. Therefore, monitoring efforts survey only those compounds selected by the analyst. In the 1970s, the U.S. Environmental Protection Agency established a list of priority pollutants consisting of 129 compounds chosen out of thousands of candidates. The U.S. Geological Survey's Toxic Substances Hydrology Program has conducted research on the analysis and detection of these compounds in surface waters, and recently published the first comprehensive study of them. Although this list remains the standard for environmental assessments, it ignores many highly relevant chemicals.

Recent advances in analytic techniques have allowed the measurement of anthropogenic chemicals in the environment that were not previously readily detectable. Many of these compounds are, or were, produced in high volumes and were introduced to the environment during their production, disposal, or use. Examples include insecticides, pharmaceuticals, antibiotics, hormones, fire retardants, and industrial chemicals. These new compounds—some banned and some still in production—are long-lived and can accumulate to high concentrations in the environment, wildlife, and humans. Due to atmospheric and oceanic long-range transport, several of these compounds have migrated throughout the world, and are even found in distant Arctic areas, where they accumulate in marine mammals and in humans.

**Recommendation 15-3.** The National Oceanic and Atmospheric Administration, U.S. Geological Survey, and U.S. Environmental Protection Agency, working with other appropriate entities, should ensure that the national water quality monitoring network includes the following elements: clearly defined goals that fulfill user needs and measure management success; a core set of variables to be measured, with regional flexibility to measure additional variables where needed; an overall system design that determines where, how, and when to monitor and includes a mix of time and space scales, probabilistic and fixed stations, and stressor- and effects-oriented measurements; technical coordination that establishes standard procedures and techniques; and periodic review of the monitoring network, with modifications as necessary.

## MAKING DATA ACCESSIBLE AND USEFUL

The data collected from the national monitoring network should be deposited in, and available through, a national data management system, as described in Chapter 28. Complete information about what is being analyzed and methods of analysis should be shared. Once monitoring data are collected, they must be translated into timely and useful information products that are readily accessible to decision makers and the public. The regional ocean information programs, as described in Chapter 5, should be helpful in providing coastal managers with the monitoring information needed to inform their decisions.



**Recommendation 15-4.** The National Oceanic and Atmospheric Administration, U.S. Geological Survey, and U.S. Environmental Protection Agency, working with other appropriate entities, should ensure that water quality monitoring data are translated into timely and useful information products that are easily accessible to the public and linked to output from the Integrated Ocean Observing System.

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<sup>1</sup> National Research Council. *Opportunities to Improve the U.S. Geological Survey National Water Quality Assessment Program*. Washington, DC: National Academy Press, 2001.

<sup>2</sup> U.S. Geological Survey. "The Strategy for Improving Water-Quality Monitoring in the United States—Summary." <<http://water.usgs.gov/wicp/Summary.html>> Accessed January 20, 2004.

**CHAPTER 16:****LIMITING VESSEL POLLUTION AND IMPROVING VESSEL SAFETY**

*The benefits from vessel activities are significant, but they also present risks to people and the environment that need to be effectively addressed. Limiting vessel pollution, improving vessel safety, and addressing potential security threats associated with vessel operations depend on responsible owners and operators, conscientious crews, enforceable national and international standards, and development of new technologies and management approaches. There is also a need for heightened awareness and better real-time information about the full array of offshore activities to ensure safety, security, and environmental quality.*

**ASSESSING THE BENEFITS AND RISKS OF VESSEL ACTIVITIES**

Commercial and recreational vessel activities contribute substantially to the U.S. economy. Ships carry more than 95 percent of the nation's overseas cargo<sup>1</sup> and 9 to 15 percent of its domestic freight.<sup>2,3</sup> The U.S. cruise industry and its passengers generated almost \$12 billion in annual spending in 2002,<sup>4</sup> and recreational boaters spend an estimated \$30 billion a year.<sup>5</sup> However, as with all industries, the many benefits derived from vessel operations are accompanied by safety and environmental risks that require effective government oversight. A 1995 U.S. Coast Guard study identified human error as the cause of approximately 80 percent of all maritime casualties.<sup>6</sup> Recent events—such as an oil spill from a barge in Buzzards Bay, Massachusetts that caused significant economic and environmental damage and a Staten Island, New York ferry accident that resulted in multiple fatalities—demonstrate that protecting the environment and enhancing safety require continued focus and vigilance.

It is worth noting that many of the pollutants associated with vessels also have land-based sources. In fact, 80 percent of all ocean pollution originates from land-based activities, including many of the types of pollution commonly associated with vessel activities.<sup>7</sup> For example, spills due to shipborne oil transportation, including spills from tankers, account for only about 9 percent of the human input of petroleum into North American waters.<sup>8</sup> Nevertheless, the existence of other sources does not diminish the importance of finding better ways to reduce vessel pollution.

Improving commercial vessel safety, security, and environmental protection is an international concern. Foreign flag vessels, subject primarily to the jurisdiction and control of other governments, carry more than 90 percent of international commercial freight entering and departing the United States<sup>9</sup> and account for 95 percent of passenger ships and 75 percent of cargo ships operating in U.S. waters.<sup>10</sup> Consequently, it is critical for the United States to participate in worldwide efforts to manage vessel operations. The principal forum for developing international regulations and guidelines on vessel safety, security, and environmental protection is the United Nations International Maritime Organization (IMO). The IMO consists of 163 member nations including the United States, whose combined fleets represent more than 98 percent of world vessel tonnage.<sup>11</sup>

## STRENGTHENING VESSEL SAFETY, SECURITY, AND ENVIRONMENTAL COMPLIANCE

Vessel owners and operators and government agencies responsible for oversight of vessel operations share responsibility for continued improvement in vessel safety, security, and environmental compliance. Improvements to date have been based on a combination of voluntary and regulatory measures, including a broad array of guidelines and mandatory regimes for domestic and international operations. Over the past few years, attention has been focused on better implementation, oversight, and enforcement of existing requirements.

The success of all these efforts will depend on a broad domestic and international framework with several components. A key component of the framework is a strong voluntary commitment on the part of vessel owners and operators to build a culture that incorporates safety, security, and environmental protection as important and valued aspects of everyday vessel operations. Another important component is an international commitment to effective oversight and enforcement. This applies particularly to those with primary responsibility for vessel operations and receiving ports.

### A Culture of Compliance and Safety

Voluntary partnerships between U.S. government agencies and vessel owners and operators are an important, non-regulatory means of promoting vessel safety and encouraging compliance with environmental regulations. For example, the Coast Guard's Prevention Through People program focuses on the human component of vessel operations to identify risks and develop solutions to common problems, emphasizing the industry's lead role in safety management.

Such partnerships have been credited for reductions in vessel accidents and oil spills. However, the process of building a culture of safety also requires a strong commitment within industry. Safety and environmental plans should be effectively incorporated into routine vessel operations, including investments in improved workplace safety and training. Also important to success are reliable means of measuring the success of these initiatives, as reflected in crew and company performance, including extensive use of third-party audits. The Coast Guard has developed incentives that reward companies and vessels with excellent performance records. The most effective incentives are those that facilitate cargo delivery or other vessel operations, such as reduced government oversight or inspections, which translate directly into lower operational costs.

**Recommendation 16–1. The U.S. Coast Guard should encourage industry partners engaged in vessel management to develop stronger voluntary measures, particularly those that reward crew member contributions, as part of a continuing long-term effort to build a culture of safety, security, and environmental compliance in routine vessel operations.**

Despite these positive developments, effective oversight and enforcement will remain critical to improved safety and environmental protection. While most vessel owners and operators comply with international and domestic requirements to develop safety management plans, the evidence of continuing accidents, criminal prosecutions for falsifying documents, and intentional violation of environmental protection laws indicate that some owners and operators are not implementing these plans. Coast Guard experience has found that performance-based inspections, focusing on demonstrations of crew competencies and incorporation of vessel safety management plans into daily operations, provide the best means of evaluating the effectiveness of implementation efforts.

Vessel oversight and enforcement took on a dramatic new dimension after September 2001, when a series of new security requirements were developed to address vulnerabilities in the U.S. marine transportation system. In 2002, Congress enacted the Maritime Transportation Security Act (MTSA), establishing a comprehensive approach to maritime security, and the IMO adopted a broad new security regime for international shipping, all scheduled to enter into force in July 2004. These initiatives are part of a broader homeland security strategy that places a series of new demands on Coast Guard resources.

Concern has been expressed in Congress and elsewhere about the impact of increased security responsibilities on other Coast Guard missions. U.S. General Accounting Office (GAO) reports have documented a decline in resources in a number of other mission areas, including marine safety and environmental protection, since September 11, 2001, and have called upon the Coast Guard to develop a comprehensive, balanced resource utilization strategy.<sup>12,13</sup>

A 2004 report from the National Research Council identified four key national interests related to the marine transportation system: ensuring marine safety; protecting the marine environment; facilitating commerce; and providing for national security.<sup>14</sup> In planning for future resource needs and allocation, it will be important to ensure that sufficient resources are available to meet new security demands without diminishing the resources necessary to sustain and strengthen marine safety and environmental compliance. For example, performance-based vessel inspections, while the most effective means of verifying compliance, are resource intensive. These inspections have played a critical role in identifying and correcting potential problems, and in assessing the effectiveness of overall efforts to improve safety and environmental compliance.

**Recommendation 16–2. Congress should provide the U.S. Coast Guard with the resources necessary to sustain and strengthen the performance-based inspection program for marine safety and environmental protection. Coast Guard resource commitments in these areas should be coordinated with new demands for vessel security inspections and other security requirements.**

### Flag State Oversight and Enforcement

Government responsibility for oversight and enforcement is vested primarily in the *flag state*, the nation in which a vessel is registered and whose flag the vessel flies. Flag states are responsible for ensuring their vessels' compliance with applicable safety, security, and environmental standards, and for verifying the accuracy of documents and certificates issued under their authority. This responsibility requires flag states to have the necessary domestic laws, administrative infrastructure, and qualified personnel in place to oversee vessel inspections, ensure crew competency, investigate vessel accidents, and take appropriate regulatory and enforcement actions.

Although many flag states take their responsibilities seriously and are active participants within the IMO, oversight and enforcement vary dramatically. Others lack the capacity to adequately oversee and enforce international requirements. In many instances, flag states rely heavily on independent organizations, such as classification societies, for technical expertise and guidance concerning these responsibilities. These organizations may be designated to exercise authority on behalf of a flag state, in which case they are referred to as “responsible organizations.” Many of these organizations are highly professional and competent, but not all adhere to high standards of performance.

Some flag states, known as open registries, allow ship owners to register vessels and fly their flag without any genuine link between the nationality of the owner and the flag state. A few open registries have little interest in the duties of a flag state, other than to collect registration fees. These flag states become havens for owners of substandard vessels seeking to avoid meaningful oversight. The ability to rapidly change vessel registry

from one flag state to another makes it easy for irresponsible owners to avoid effective flag state controls over their operations.

Over the past decade, the IMO has developed guidelines to improve flag state oversight and enforcement including a self-assessment program. However less than one-third of IMO member nations have participated in the program, and a consistently low number of flag states submit mandatory reports to the IMO on actions taken to control pollution violations.<sup>15</sup> An IMO research study completed in 2001 also found an unexpectedly high incidence of fraudulent crew certification documents, with over 80 percent of those surveyed having detected forged certificates in the last five years.<sup>16</sup>

Mounting international security concerns have made effective flag state oversight and control even more urgent. Recently approved IMO security initiatives require flag states to enforce comprehensive new security measures for vessels flying their flag, including the implementation of vessel security plans, development of detailed and regularly updated vessel histories, and verification of vessel and crew security documentation.

The IMO also recently approved the establishment and development of a voluntary Model Audit Scheme to assess how effectively member states are implementing and enforcing convention standards and to provide feedback on audit results. The IMO has been working on a code that clearly enumerates flag state, port state, and coastal state responsibilities. The G-8 nations (the United States, France, Russia, the United Kingdom, Germany, Japan, Italy, Canada) and representatives from the European Union agreed to work together to accelerate the introduction of these IMO initiatives and expand technical cooperation programs to assist flag states in meeting their international obligations.<sup>17</sup>

**Recommendation 16–3. The United States should work with other nations to accelerate efforts at the International Maritime Organization to enhance flag state oversight and enforcement.**

*These efforts should include implementation of:*

- *a code outlining flag state responsibilities and obligations.*
- *a voluntary audit regime, to be followed by adoption of a mandatory external audit regime for evaluating flag state performance.*
- *measures to ensure that responsible organizations, acting on behalf of flag states, meet established performance standards.*
- *increased technical assistance, where appropriate, for flag states that participate in self-assessments and audits.*

**Port State Control**

Nations have the authority to ensure that foreign flag vessels visiting their ports are in compliance with applicable international and domestic requirements. This verification process, exercised through port state control programs, has taken on added significance given the failure of some vessel owners and flag states to effectively exercise their oversight responsibilities.

***U.S. Port State Control***

The Coast Guard currently carries out a port state control program that allocates limited inspection resources to the highest-risk vessels, based on an assessment of the vessel owner, flag state, classification society, performance history, and vessel type. The assessment also considers whether the flag state is a party to important international conventions. In 2002, over 7,000 vessels from eighty-one flag states made more than 53,000 port calls in the United States. The Coast Guard conducted 10,518 inspections leading to the detention of 179 vessels for serious violations.<sup>18</sup>

The Coast Guard's QUALSHIP 21 program rewards foreign flag vessels that have attained particularly high levels of compliance with international safety and environmental requirements by reducing their Coast Guard inspections. This can expedite port calls and reduce costs. The Coast Guard is currently working to develop additional incentives for QUALSHIP 21 vessels.

The Coast Guard's annual reports on port state control identify a small number of flag states whose vessels have consistently poor records, with repeated detentions for major safety and environmental compliance violations.<sup>19</sup> Beginning in 2004, the U.S. port state control program will be expanded to include comprehensive vessel security inspections that will provide additional information on flag state performance.

Poor oversight by flag states places greater burdens on Coast Guard resources; the higher the potential risk presented by a vessel, the greater the need to assign resources to address that risk. More stringent action against irresponsible flag states may encourage vessel owners to register with flag states that have better oversight regimes and performance records, and reduce the burden on port state resources. The Coast Guard should evaluate the potential benefits of additional measures directed at irresponsible flag states owners, such as denial of port entry for all vessels registered with a particular flag state or under control of owners and operators who demonstrate a repeated, material failure to enforce applicable security, safety, or environmental protection requirements.

### *International Port State Control*

Port state control programs around the world can become more effective by sharing information on successful program management practices, and by sharing information on vessel histories and inspections. An international memorandum of understanding, signed by the Coast Guard, established EQUASIS, an independent, nonprofit database designed to provide global access to impartial information on individual vessels to help reduce substandard shipping. This database can be accessed free of charge by anyone, including port states and vessel operators. Although the Coast Guard actively participates in development of EQUASIS policy and provides and uses information from the database, an appropriate funding mechanism has not been identified to allow regular U.S. support for this important information-sharing effort.

**Recommendation 16–4. The U.S. Coast Guard, working with other nations, should establish a permanent mechanism to strengthen and harmonize port state control programs under the auspices of the International Maritime Organization. The Coast Guard should provide sustained funding to support an international vessel information database that can be used to enhance the effectiveness of port state control efforts.**

## REDUCING VESSEL POLLUTION

Strengthening commitments to environmental protection, flag state oversight, and port state control will help prevent and reduce the impacts of vessel pollution. However, effective reduction of vessel pollution will also require the development of new control measures. Of particular concern are vessel waste discharges containing pathogens and nutrients, air emissions, and oil releases. (The role of vessels in the spread of invasive species is addressed in Chapter 17.)

### **Waste Stream Discharges**

Every day, vessels ranging from large cruise ships to small recreational boats discharge wastes into coastal waters. The waste streams from recreational vessels primarily contain sewage, while cruise ships discharge both sewage and toxic substances. These wastes, if not properly disposed of and treated, can be a significant source of pathogens and nutrients with the potential to threaten human health and damage shellfish beds,



coral reefs, and other aquatic life. According to the U.S. Environmental Protection Agency (EPA), the amount of bacterial pollution in the discharge of untreated sewage from just one recreational boat is equivalent to the amount in the treated sewage of 10,000 people during a similar time period.<sup>20</sup>

The Clean Water Act prohibits the discharge of untreated sewage in U.S. internal waters and within three miles of the coast. It also allows individual states to ask EPA to establish special no-discharge zones in their waters, within which the discharge of even treated sewage is prohibited. The Clean Water Act also directs EPA and the Coast Guard to establish discharge and design standards for marine sanitation devices (MSDs).

Concerns about the impacts of vessel waste and the effectiveness of Clean Water Act controls increased in the 1990s, along with the increase in cruise ships and recreational vessels. An Alaskan study conducted in 2000 found that most cruise ship MSDs failed to treat sewage to levels necessary to meet federal standards, despite claims by the manufacturers. Additional restrictions on the discharge of wastewater in Alaskan waters had already been voluntarily initiated by the cruise lines earlier that year, in response to growing concerns about potential wastewater impacts.<sup>21</sup>

Decreasing the detrimental effects of these discharges will require a number of actions, including modifications to current statutes and regulations to strengthen standards, improved public outreach and education, and additional research to better understand waste stream impacts.

### ***Cruise Ships***

The cruise industry has grown rapidly since the 1980s. By the end of 2002, 176 vessels were operating in the North American cruise industry, and U.S. ports handled 6.5 million cruise embarkations, an increase of over 10 percent from 2001.<sup>22</sup> While growth is expected to slow somewhat over the next several years, double-digit growth is predicted to continue in the near term.<sup>23</sup> This rapid growth has been accompanied by increasing concerns about the environmental impacts of waste discharges from cruise ships. The United States accounts for about 70 percent of global cruise embarkations; thus a large portion of cruise ship operations occur in or near U.S. waters (Figure 16.1).<sup>24</sup>

Cruise ships can carry as many as 5,000 passengers and crew, generating large amounts of wastewater, including blackwater (sewage), graywater (drainage from dishwashers, showers, laundry, baths, and washbasins), and hazardous substances. Estimates indicate that a single cruise ship can generate from 140,000 to 210,000 gallons of blackwater and a million gallons of graywater per week.<sup>25,26</sup> Of particular concern are the cumulative environmental impacts caused when cruise ships repeatedly visit the same environmentally sensitive areas.

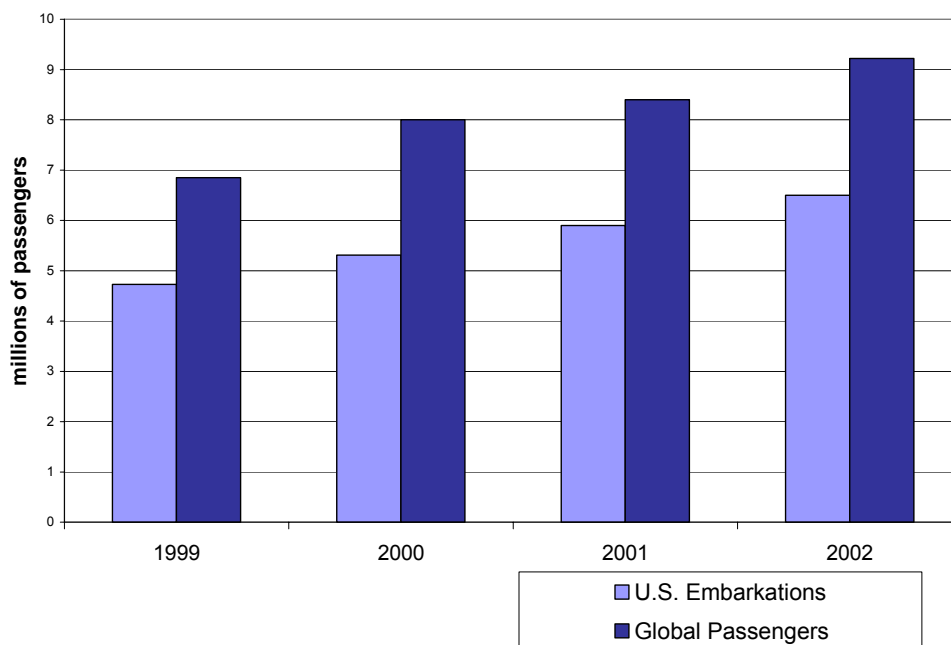
Between 1993 and 1998, eighty-seven illegal discharge cases, some involving multiple discharges, were brought against cruise lines in the United States resulting in significant civil and criminal penalties<sup>27</sup> While the number of confirmed cases gradually declined during that period, new cases leading to additional civil and criminal penalties have continued over the past several years. Industry efforts to address this problem have included the voluntary adoption of comprehensive management plans for handling cruise ship wastes, participation in research partnerships with government and other public and private stakeholders to investigate the impacts of cruise ship pollution, and significant investments in new technologies to reduce environmental impacts.

In response to particular concerns about the impacts of cruise ship discharges in Alaska, a new federal statutory regime applicable only to Alaskan waters was developed in 2000, followed by a state statutory regime in 2001. These laws included wastewater discharge standards and provisions for sampling and testing, recordkeeping, and inspections, as well as flexibility to encourage voluntary application of innovative



wastewater treatment technologies and methods. However, no comprehensive wastewater management regime is in place for all large passenger vessels operating in U.S. waters.

**Figure 16.1. Most Cruise Travel Originates in U.S. Waters**



Passengers boarding cruise ships at U.S. ports account for over 70 percent of global passengers. Due to the continued growth of U.S. cruise ship operations, appropriate treatment and disposal of wastewater discharges from these ships will continue to be a concern for maintaining water quality and preventing harm to marine organisms in U.S. waters.

Source: Business Research & Economics Advisors. *The Contribution of the North American Cruise Industry to the U.S. Economy in 2002*. Exton, PA: International Council of Cruise Lines, August 2003.

A new regime is needed that provides clear, uniform requirements for controlling the discharge of wastewater from large passenger vessels, as well as consistent interpretation and enforcement of those requirements. The benefits of the Alaskan approach should be extended to other sensitive ocean and coastal areas that experience significant cruise ship traffic. Any new regulatory regime should be science-based and incorporate new results, such as recent EPA studies on the dilution and dispersal of discharges from vessels while underway.<sup>28</sup> Effective enforcement will require that accurate records be maintained to allow the regulated community and enforcement officials to track the treatment and discharge of waste.

**Recommendation 16–5. Congress should amend the Clean Water Act to establish a new national regime for managing wastewater discharges from large passenger vessels, including: uniform discharge standards and waste management procedures; thorough recordkeeping requirements to track the waste management process; required sampling, testing, and monitoring by vessel operators using uniform protocols; and flexibility and incentives to encourage industry investment in innovative treatment technologies.**

### *Recreational Vessels*

Millions of small recreational boats also discharge significant volumes of waste to coastal waters. Many recreational boaters rely on MSDs to treat waste before discharge or store waste until it can be pumped out at

land-based facilities. MSD performance and design standards, however, have not been updated since the mid-1970s and do not account for new technology or the operational life of an MSD system. As a result, many MSDs currently used on recreational vessels do not provide adequate environmental protection, particularly with respect to pathogen discharges.

**Recommendation 16–6.** The U.S. Environmental Protection Agency should revise the Clean Water Act marine sanitation device (MSD) regulations to require that new MSDs meet significantly more stringent pathogen-reduction standards. The U.S. Coast Guard should require manufacturers to provide warranties that MSDs will meet these new standards for a specified time period.

### *Waste Pumpout Facilities*

Pumpout facilities are essential for handling waste from boats equipped with holding tanks. EPA is responsible for determining whether adequate pumpout facilities are available to recreational boaters before approving most state no-discharge zones. In addition, the Clean Vessel Act provides funding to states, through the U.S. Fish and Wildlife Service (USFWS), to purchase and install sewage pumpout stations and portable toilet waste dump stations, and to provide environmental education to boaters. States may also award grants to marinas to construct these facilities. Despite these programs, the current shortfall in adequate pumpout facilities makes it virtually impossible for boaters to comply with prohibitions against the discharge of untreated waste in some coastal areas.

**Recommendation 16–7.** The U.S. Environmental Protection Agency (EPA) should conduct a thorough assessment, including field inspections, to verify the availability and accessibility of functioning pumpout facilities in existing no-discharge zones and prior to the approval of any new no-discharge zones. EPA, working with other appropriate entities, should increase voluntary installation of pumpout facilities.

**Recommendation 16–8.** Congress should provide incentives for boat owners to install improved treatment devices and should increase funding for grants to build pumpout facilities under the Clean Vessel Act. Congress, with input from the National Ocean Council, should also consider transferring the Clean Vessel Act grant program to the U.S. Environmental Protection Agency to consolidate the administration of programs related to marine sanitation devices.

## **Air Emissions**

### *Large Commercial Vessels*

Most commercial ships are powered by marine diesel engines that use fuels containing high concentrations of contaminants.<sup>29</sup> These engines have high emissions on a per engine basis and contribute to high ozone and particulate matter levels in many coastal and port areas.<sup>30</sup> A study of global impacts from large vessel air emissions indicates that approximately 80 percent of vessel air emissions occur within 200 miles of the coast, and that a major part of these emissions are concentrated in a few areas in the Northern Hemisphere, primarily along the east and west coasts of the United States, in the North Pacific, and in northern Europe. International and domestic marine trade is predicted to more than double in the next twenty years, reinforcing the need to expeditiously develop and implement measures to abate vessel-generated air pollution.<sup>31</sup>

New engine types that consume less fuel and emit less pollution are being installed and evaluated. Some vessel owners and operators are also replacing high-sulfur fuels with more expensive, low-sulfur fuels. These voluntary measures are effective in reducing air pollution, but often involve significantly increased costs. Economic incentives can encourage such actions by helping to offset the costs, a useful complement to regulatory measures. Several incentives were suggested during the development of EPA's large marine engine

emission regulations. At the state and port levels, these suggested incentives include differentiated port fees based on a vessel's environmental profile, matching grant programs, and the greater use of shore power where it is determined to be safe, cost-effective, and environmentally advantageous. Future possibilities include market-based measures such as pollution credit trading programs, including trading between fixed and mobile sources.<sup>32</sup> Europe is also considering market-based measures to reduce emissions, such as relating port fees to vessel emission levels, linking fuel taxes with fuel quality, and developing emission trading mechanisms.

**Recommendation 16–9. The U.S. Environmental Protection Agency, working with other appropriate entities, should investigate and develop incentive-based measures that result in measurable voluntary reductions in vessel air emissions.**

International initiatives to curb emissions from large vessels have centered on IMO development of a new Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL). Annex VI establishes limits on nitrogen oxide emissions and also addresses the sulfur content of fuel, releases of ozone-depleting substances, volatile organic compounds from refueling, and shipboard incineration. Annex VI also allows nations to establish Sulfur Oxide Emission Control Areas; efforts are already underway to seek this designation for certain European waters. (See Appendix 6)

**Recommendation 16–10. The United States should ratify MARPOL Annex VI and work for adoption by the International Maritime Organization of stricter air emission standards that reflect advances in marine engine technology, availability of cleaner fuels, and improved operational practices. The U.S. Environmental Protection Agency should consider the potential designation of certain U.S. ocean and coastal areas with impaired air quality as Annex VI Sulfur Oxide Emission Control Areas.**

### ***Recreational Vessels***

At the other end of the spectrum, the millions of smaller recreational boats with gasoline-fueled, spark-ignition engines may contribute more than 10 percent of total hydrocarbon emissions in some areas of the nation,<sup>33</sup> contributing to ozone formation and associated health problems. EPA has issued regulations under the Clean Air Act to reduce these emissions by requiring the use of significantly improved two-stroke engine designs or substitution with four-stroke engines, either of which will significantly reduce air emissions. EPA estimates that by 2025, after the new engines are in widespread use and the old engines have been largely retired, there will be a 75 percent reduction in hydrocarbon emissions from recreational vessels.<sup>34</sup> Environmental benefits could be achieved even more rapidly if incentives were provided for boat owners to retire old engines before required.

**Recommendation 16– 11. Congress should create an incentive program for boat owners to install or use less polluting engines in recreational boats.**

EPA can also work with state government, recreational boating associations, and marinas to expand education and outreach programs urging recreational boaters to properly maintain engines and fuel systems to optimize combustion and to replace old two-stroke engines more rapidly.

### **Oil Releases**

Vessels can release oil into the marine environment in a variety of ways, including accidental spills of oil and fuel, release of oil during normal engine operations, and intentional discharges. Two devastating recent spills off the coast of Europe involving older single-hull tankers—the *Erika* in 1999 and the *Prestige* in 2002—clearly demonstrate the challenges presented as ship operators and government agencies work to prevent future spills.

### ***Single-Hull Vessel Phase-outs***

One of the major initiatives designed to prevent oil spills is the phase-out of single-hull tankers and barges and their replacement by double-hull vessels. In December 2003, IMO adopted amendments to MARPOL, scheduled to enter into force in 2005, that accelerate international phase-out schedules for single-hull tankers and introduce a ban on carriage of heavy oils by certain single-hull tankers. The IMO provisions reflect similar actions that entered into force in the European Union in October 2003.

Prior to recent international actions, concerns had been raised in the United States about sufficient oil carriage capacity, as regulations under the Oil Pollution Act (OPA) required phase-outs of single-hulls. (The international phase-out schedule differs in certain respects from the schedule under OPA.) A 2000 GAO report analyzed domestic capacity in the U.S. fleet and determined that the industry had sufficient capacity in the near term, but that future capacity was less clear and merited regular examination.<sup>35</sup> As the European and IMO initiatives took shape, additional concerns were raised about their impacts, including the limitations on carriage of heavy oils and the possible diversion of single-hull tankers from the European to U.S. trade. Building on recommendations in the GAO report, the U.S. Department of Transportation and the U.S. Coast Guard need to continue to assess issues related to the phase-out of single-hull vessels. The assessments should address the capacity to meet U.S. demand for double-hull vessels and include evaluations of the impacts of recent MARPOL amendments.

### ***Aging Infrastructure***

While vessel spills are the leading source of oil releases associated with the oil transportation industry, there is also growing concern about the threats posed by aging pipelines and other oil transportation facilities.<sup>36</sup> Reflecting these concerns, Congress and the Office of Pipeline Safety have introduced new statutory and management measures designed to improve pipeline safety. The most effective long-term approach to protection of the marine environment from transportation-related oil spills is a comprehensive, risk-based assessment of potential threats, prioritization of responses, and a coordinated plan of action among agencies responsible for different segments of the oil transportation industry.

**Recommendation 16–12. The U.S. Department of Transportation, U.S. Coast Guard, U.S. Environmental Protection Agency, and Minerals Management Service should conduct a risk-based analysis of all oil transportation systems, identify and prioritize areas of greatest risk, and develop a comprehensive plan for long-term action to reduce the threat of significant spills.**

### ***Places of Refuge***

A *place of refuge* is the term given to a port or protected coastal area that can accommodate ships in distress and help prevent or mitigate the impact of spills. In 2001, the *Castor*, a fully laden tanker that had developed a structural problem in the Mediterranean, was forced to remain at sea for thirty-five days until finally allowed into sheltered waters for cargo transfer and repairs. Many believe that the catastrophic impacts caused by the 2002 *Prestige* oil spill off the coast of Spain may have been avoided or significantly reduced had the distressed vessel been allowed into sheltered waters to transfer its cargo, rather than towed farther out to sea.

In December 2003, the IMO approved new guidelines on places of refuge for distressed ships when human life is not threatened. The guidelines are based on the premise that the best way to prevent damage from the progressive deterioration of a vessel is to transfer its cargo and fuel, and that this is best accomplished in a place of refuge. The guidelines provide a framework for assessing individual cases and taking appropriate action. However, recognizing that the potential economic and environmental consequences of bringing a distressed vessel to the coast are likely to generate political involvement, the guidelines also recommend actions to facilitate communication and decision making during the time of crisis.

Additional work is needed in the United States to create an effective process for responding to vessels seeking refuge. While this will be difficult, it will be too late to find satisfactory solutions once an incident like the *Prestige* disaster is underway. A series of government and industry forums have identified many issues to be addressed, among them: establishing a single point of contact for ship-to-shore communications; identifying available salvage, lightering, and technical resources in local areas; identifying the responsible decision makers at federal, state, and port levels; resolving financial protection, liability, and compensation issues; and deciding whether potential places of refuge should be designated in advance. There is a broad consensus that contingency plans should: allow for consistent implementation at the national, regional, and port levels; provide specific direction on how to receive and act upon requests for assistance in a timely and coordinated manner; and establish clear lines of authority and responsibility for deciding whether to grant a ship's request for refuge.

**Recommendation 16-13. The U.S. Coast Guard, working with the spill response community, should develop comprehensive policy guidance and contingency plans for places of refuge in the United States. The plans should clearly delineate decision-making authorities and responsibilities and provide for a coordinated and timely assessment and response to vessels seeking a place of refuge.**

### ***Pollution Prevention and Response***

U.S. efforts to reduce oil spills from vessels have been very successful, largely due to requirements established by OPA and initiatives by industry working in partnership with government agencies, particularly the Coast Guard. Following the enactment of OPA in 1990, oil released through vessel spills in the United States dropped by more than 60 percent, from over fourteen gallons per million shipped between 1983 and 1990 to 5 gallons per million between 1991 and 1998 (Figure 16.2).<sup>37</sup>

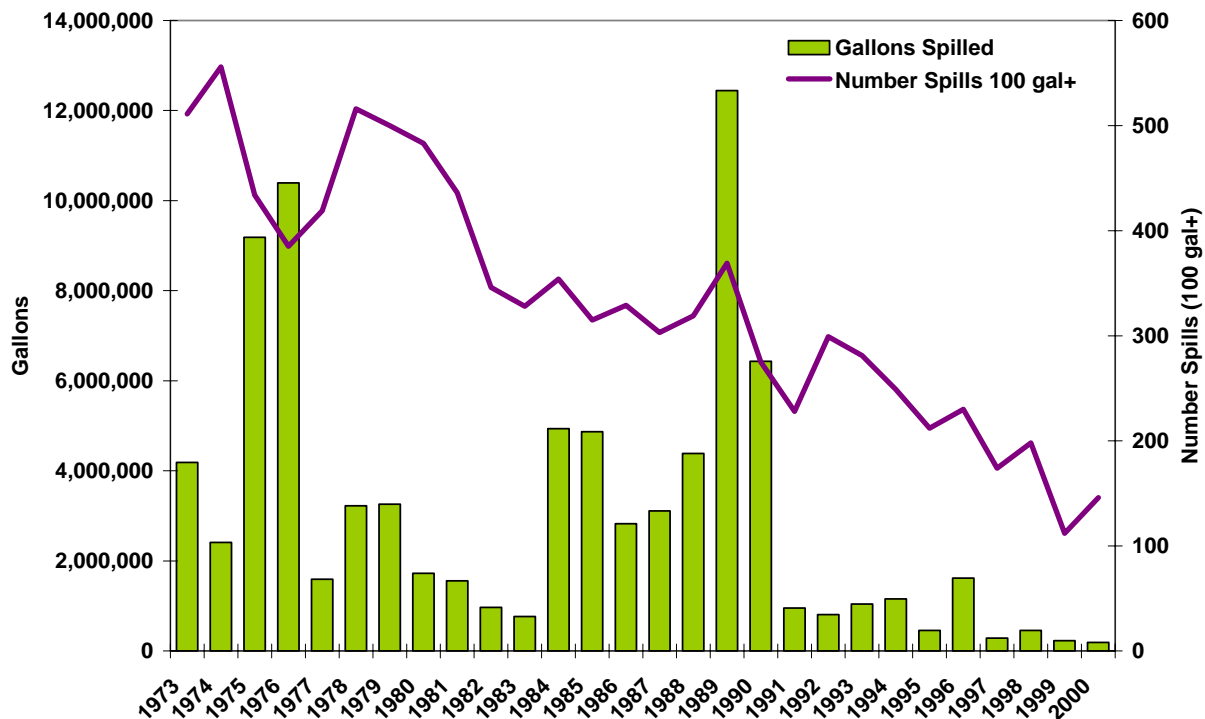
While barge spills have also declined dramatically in the last decade, a 2002 National Research Council report indicated that between 1990 and 1999 the amount of oil released into U.S. waters from barge spills, particularly from spills of heavy distillates, exceeded spills from other vessel sources, including tankers.<sup>38</sup>

Sunken and abandoned vessels also pose environmental dangers. These wrecks may still contain significant amounts of oil or other hazardous substances and represent an increasing threat of gradual or sudden releases to the environment as the vessels age and deteriorate.

When a spill does occur, the United States has a well-developed National Response System (NRS) to manage threats from oil discharges, hazardous chemical releases, and other toxic spills. The NRS includes: a National Response Team made up of sixteen federal agencies; Regional Response Teams, with federal, state, and territorial representatives; Area Committees; and Local Emergency Planning Committees under supervision of their State Emergency Response Commissions. National, regional, and area contingency plans provide an organizational structure, develop policy guidance, and coordinate federal, state, and local responses to discharges and threats of discharges. Federal on-scene coordinators, designated in advance from the Coast Guard, coordinate response resources and efforts during an incident.

The need remains for continued vigilance, dedication of resources, prioritization of threats, and development of additional preventive actions to reduce the number and impacts of oil spills in U.S. waters.

**Figure 16.2. The Oil Pollution Act Curbs Spills in U.S. Waters**



While the overall number of oil spills has decreased steadily since the early 1970s, the volume of oil spilled fluctuated significantly between 1973 and 1990. However, following the *EXXON Valdez* spill in 1989 and the resulting passage of the Oil Pollution Act in 1990, the amount of oil released into the environment was significantly reduced. Data courtesy of Environmental Research Consulting, Cortlandt Manor, NY.

### *Oil from Recreational Vessels*

The millions of recreational vessels and personal watercraft with two-stroke outboard motors are estimated to be a substantial source of petroleum contamination in U.S. waters, although the true magnitude of the problem remains unclear. The National Research Council has estimated that two-stroke outboard motors release anywhere between 0.6 and 2.5 million gallons of oil and gasoline into U.S. coastal waters every year.<sup>39</sup> Petroleum products also spill into coastal waters when boaters are refueling.

Most of the approximately ten million gasoline-fueled recreational motorboats and personal watercraft have older two-stroke engines that will continue to discharge air and water pollutants until they are retired.<sup>40</sup> Actions to reduce air pollutants from recreational vessel engines (discussed above), including upgrades for two-stroke engines, replacement with four-stroke engines, owner incentives, and general boater education, will also reduce discharges of oil, gasoline, and fuel additives.

## INCREASING KNOWLEDGE TO GUIDE CHANGE

### Additional Research Needs

A common theme in any pollution prevention strategy is the need to acquire a better understanding of the impacts of various forms of pollution and the potential for new control technologies. Research can help identify the degree of harm represented by different human activities and can assist in prioritizing limited resources to address the most significant threats. Research must also be at the heart of any science-based



approach toward developing new regulatory and non-regulatory measures to control vessel pollution. Useful research directions include investigations of:

- processes that govern the transport of pollutants in the marine environment;
- small passenger vessel practices, including the impacts of stationary discharges;
- disposal options for concentrated sludge resulting from advanced sewage treatment on large passenger vessels;
- cumulative impacts of commercial and recreational vessel pollution on particularly sensitive areas, such as coastal areas with low tidal exchange and coral reef systems; and
- impacts of vessel air emissions, particularly in ports and inland waterways where the surrounding area is already having difficulty meeting air quality standards.

These examples represent only a small fraction of the research that is needed to increase our understanding of, and our ability to respond to, potential threats to our marine environment from vessel pollution.

**Recommendation 16–14. The U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. Coast Guard, and other appropriate public and private entities should support a vigorous research program on the impacts of all types of vessel pollution. Research results should be used to guide management priorities, develop new control technologies, determine best management practices, and create more effective regulatory regimes.**

### **Improving Awareness of Ocean Activities**

Vessel safety and environmental protection depend not only on appropriate operation of each vessel, but on the safe movement and management of all vessel traffic. Effective vessel traffic management takes place within the larger context of other coastal and ocean uses and requires accommodation between those uses and navigation.

The rapidly increasing variety and number of offshore uses, and the potential for conflicts between competing interests operating in the same area, will increase the need for information concerning the nature and extent of offshore activities. In today's highly interdependent world, efforts to ensure national security, maintain environmental quality, and manage the use of marine resources will require unprecedented awareness of activities, trends, conditions, and anomalies in the maritime domain, including those that may require some intervention.

The Coast Guard, which has a leading role in developing increased maritime domain awareness, defines it as "...the effective understanding of anything in the marine environment that could adversely affect America's security, safety, economy, or environment."<sup>41</sup> For the Coast Guard, maritime domain awareness applies equally to fisheries enforcement, illegal human migration, marine safety, environmental protection, and search and rescue efforts.

While much of the recent effort to increase maritime domain awareness has grown out of concerns for national security, heightened by the September 11, 2001 terrorist attacks, the information gained will benefit a variety of other national interests. For instance, the expanded use of the Automated Identification System not only tracks and identifies vessels for security purposes, but provides information to assist safe navigation and help reduce the risk of accidents that could adversely impact the marine environment. The information can also help identify areas of vessel congestion or potential conflicts with other uses, thus serving as a valuable management tool.

The development of greater maritime domain awareness coincides with efforts to develop more comprehensive, ecosystem-based management approaches for ocean and coastal activities. Close coordination of these efforts will help ensure that the information products developed through maritime awareness can be integrated into other monitoring and observing networks to support a broad variety of management needs.

**Recommendation 16-15. The National Ocean Council should coordinate closely with the U.S. Coast Guard to ensure that initiatives to enhance maritime domain awareness are developed and implemented to provide effective support for all ocean and coastal management needs.**

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<sup>35</sup> U.S. General Accounting Office. *Maritime Industry: As U.S. Single-Hull Oil Vessels Are Eliminated, Few Double-Hull Vessels May Replace Them*. GAO/RCED-00-08. Washington, DC, April 2000.

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**CHAPTER 17:****PREVENTING THE SPREAD OF INVASIVE SPECIES**

*The introduction of invasive aquatic species into marine and Great Lakes ecosystems costs the nation millions, or possibly billions of dollars a year in economic and ecological damage. A major source of invasive species is the discharge of ballast water from ocean-going ships. Numerous federal agencies are involved in efforts to prevent the introduction of invasive species and many laws and regulations have been developed to combat the problem, but more needs to be done to reduce this threat. Preventing introductions of invasive species or limiting their impact, will require streamlined programs and increased coordination among agencies, establishment and enforcement of domestic and international ballast water management standards, an educated public, and adequate funding.*

**ACKNOWLEDGING THE PROBLEM**

The introduction of non-native marine organisms into ports, coastal areas, and watersheds has damaged marine ecosystems around the world, costing millions of dollars in remediation, monitoring, and ecosystem damage. Invasive species are considered one of the greatest threats to coastal environments,<sup>1</sup> and can contribute substantially to altering the abundance, diversity, and distribution of many native species.<sup>2</sup> Although not every non-native species becomes an invader, the sudden availability of new habitat and absence of its natural predators can lead to runaway growth that pushes out other species. Unlike many forms of pollution that degrade over time, introduced species can persist, increase, and spread.

Invasive species, land-based and aquatic, cost the U.S. economy an estimated \$137 billion a year.<sup>3</sup> However, of the approximately \$1 billion spent in 2001 to address this problem, the U.S. Department of Agriculture (USDA) received more than 90 percent for predominantly land-based efforts,<sup>4</sup> while less than 1 percent of federal spending in 2000 was allocated to combating aquatic species.<sup>5</sup> Yet the sea lamprey has decimated a Great Lakes fishery, and aquatic plants, such as hydrilla and water chestnut, have significantly disrupted navigation. An infectious oyster disease, commonly known as MSX, was most likely introduced through the experimental release of a Japanese oyster to Delaware Bay in the 1950s,<sup>6</sup> and has devastated populations of native oysters along the East Coast.

The history of the European green crab in the United States illustrates the trajectory of many invasive species. Native to the coasts of the North and Baltic seas, the green crab has been introduced to new environments through ballast water discharge, use as fishing bait, and packaging of live seafood. The green crab was first seen in San Francisco Bay in 1989, and has now become widespread on both the Atlantic and Pacific coasts. A number of ecosystems invaded by this small crab have been significantly altered. It competes with native fish and bird species for food and may also pose a threat to Dungeness crab, clam, and oyster fisheries.

## **ASSESSING EXISTING APPROACHES**

More than a decade has passed since the first legislation was enacted to combat invasive species, yet unwanted organisms continue to enter the United States where they can cause economic and ecological havoc. Invasive species policies are not keeping pace with the problem primarily because of inadequate funding, a lack of coordination among federal agencies, redundant programs, and outdated technologies.

### **Federal Statutes**

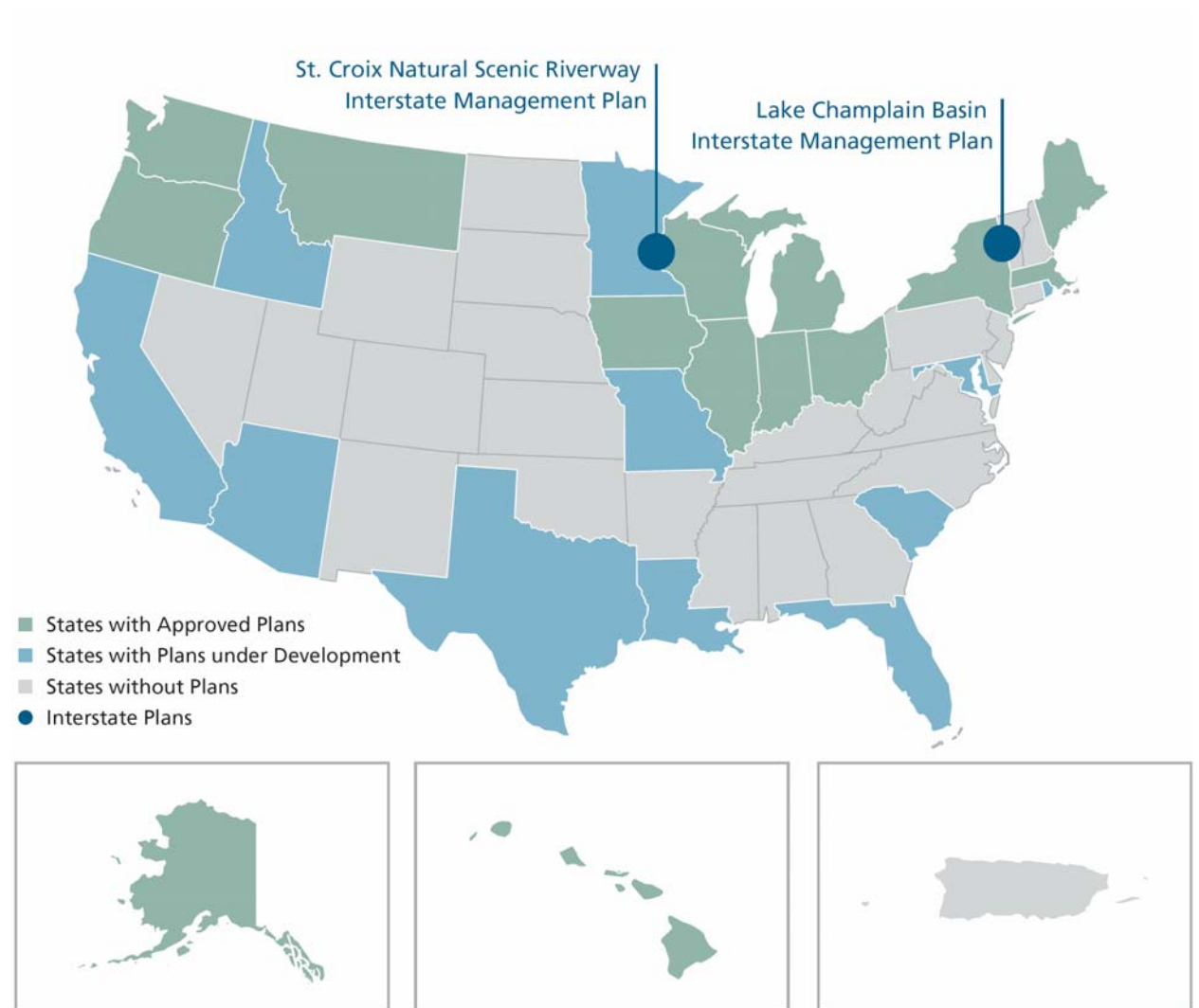
The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA), as amended by the National Invasive Species Act of 1996, is the primary federal law dealing with aquatic invasive species and ballast water management. NANPCA established the Aquatic Nuisance Species Task Force, which includes representatives from the relevant federal agencies and thirteen nonfederal stakeholders. Co-chaired by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish and Wildlife Service (USFWS), the task force is responsible for facilitating cooperation and coordination among federal, regional, and state agencies. The legislation also addresses research, prevention, species control, monitoring, and information dissemination.

The task force encourages states to develop plans for managing invasive species, and NANPCA provides authority for issuing regulations. To comply with NANPCA, the U.S. Coast Guard has established regulations and guidelines to address introductions of non-native species through the uptake and discharge of ballast water from ships.

Resource allocation for managing invasive species varies widely among federal, state, and local agencies. While NANPCA authorizes federal funding to help states implement their approved invasive species management plans, the appropriation has historically been substantially less than the authorization and has not been effective in motivating states to develop management plans. Since 1996, when this provision was included in NANPCA, only fourteen states have established plans (Figure 17.1).



**Figure 17.1. Great Lakes States are Foremost in Implementing Aquatic Nuisance Species Management Plans**

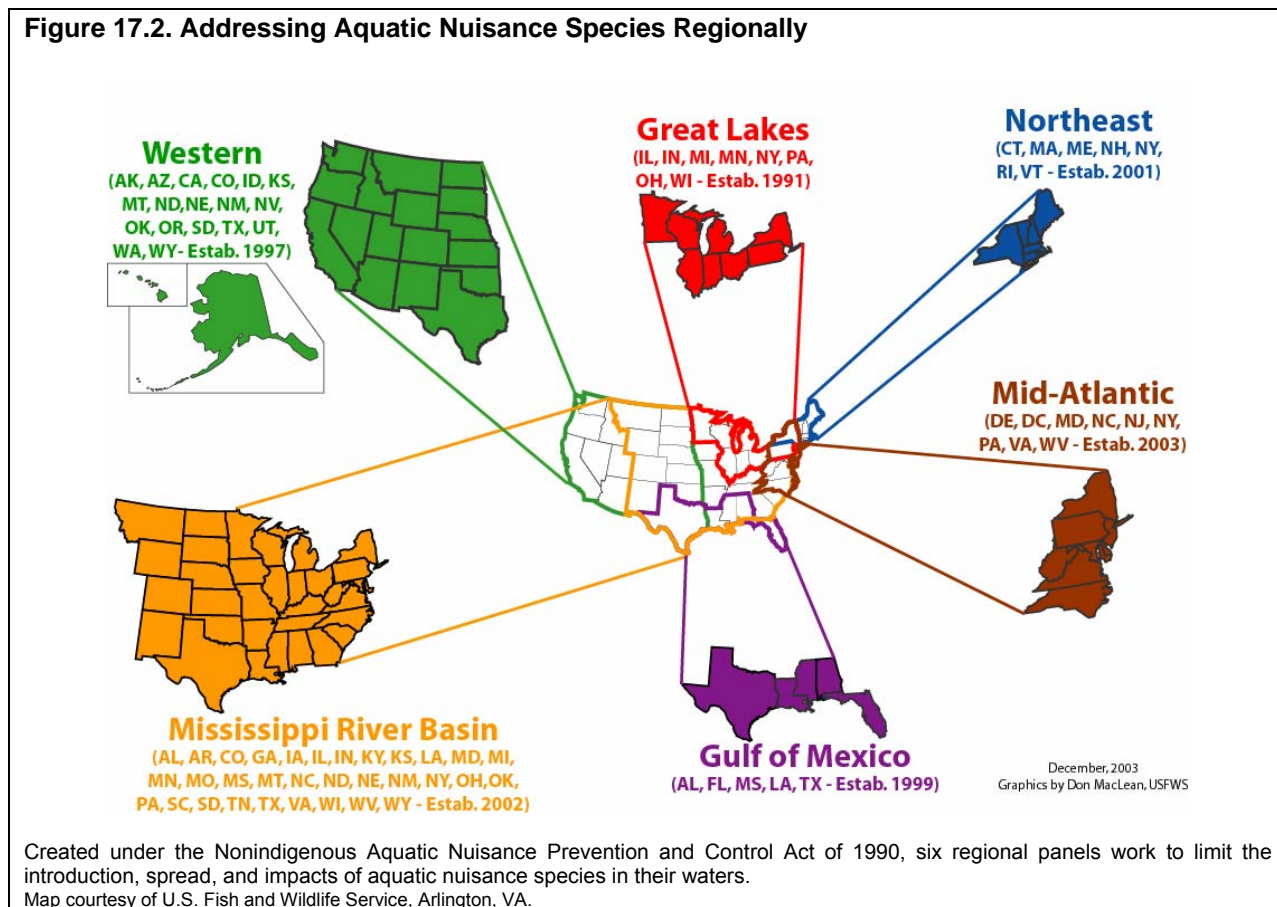


The Aquatic Nuisance Species Task Force encourages states to develop management plans for detecting and monitoring aquatic nuisance species, educating the public, and encouraging collaborative mitigation efforts. However, only fourteen states currently have plans approved by the task force. Most coastal states do not have plans, although some are developing them now.

Map courtesy of U.S. Fish and Wildlife Service, Arlington, VA.

NANPCA also encourages the formation of regional panels, which operate under goals outlined in the Act. The panels develop priorities and working groups to explore invasive species issues applicable to their areas and make recommendations for regional action. Six regional panels have been established (Figure 17.2). The implementation of invasive species plans falls primarily to state authorities, which often struggle to find the necessary resources.

**Figure 17.2. Addressing Aquatic Nuisance Species Regionally**



The National Invasive Species Council, consisting of ten federal departments and agencies, was established in February 1999 to provide national leadership on terrestrial and aquatic invasive species. In 2001, the council produced a management plan with significant input from a nonfederal advisory committee.<sup>7</sup>

The Lacey Act allows the U.S. Department of the Interior (DOI) to regulate the importation of animals found to be injurious to wildlife. However, the Act is more often used to respond to an existing invasive problem than to promote proactive approaches for preventing the introduction of problem species.

The Plant Protection Act and animal quarantine laws authorize USDA's Animal and Plant Health Inspection Service to prohibit plants and animals from entering the United States, and to require inspection, treatment, quarantine, or other mitigation. The agency can pre-clear shipments of certain organisms by requiring inspection and quarantine in the country of origin.

### State and Federal Programs

NOAA's Sea Grant program, in cooperation with USFWS and the Aquatic Nuisance Species Task Force, coordinates and funds aquatic nuisance species research, outreach and education, and administers a research and development program in ballast water management technology. Other NOAA programs address shellfish diseases and threats to essential fish habitat, including control of invasive species and invasive species removal.

The U.S. Army Corps of Engineers (USACE) has several programs that address the interactions between invasive species and federal navigation routes, including the Aquatic Plant Control Program, the Zebra Mussel Program, and the Removal of Aquatic Growth Program. USACE is also authorized to implement a 50/50 federal cost share with state and local governments for managing invasive species in navigable waterways not under federal control.

The Federal Insecticide, Fungicide, and Rodenticide Act gives the U.S. Environmental Protection Agency (EPA) regulatory authority over the use of chemicals to combat invasive species. EPA may require an environmental assessment for invasive species control activities if these chemicals are involved. And DOI's National Wildlife Refuge System program reviews strategies and recommends pilot projects involving invasive species.

In addition to these federal programs, much of the actual monitoring, management, and control of invasive species falls under regional and state jurisdiction. The Great Lakes Panel on Aquatic Nuisance Species, convened in 1991 with membership representing the eight Great Lakes states, federal and regional agencies, tribal authorities, local communities and user groups, continues its leadership role as a regional panel, supporting initiatives to prevent, detect, and respond to invasive species. Some states, such as California, have laws to address the illegal transport of certain species, the control of infected, diseased or parasitized aquatic species, and the marine aquariums pet trade.

## **IDENTIFYING MAJOR PATHWAYS FOR INTRODUCTION OF NON-NATIVE SPECIES**

The discharge of ballast water is considered a primary pathway for introduction of non-native aquatic species. Other ship-related sources, such as sea chests (openings in ship hulls used when pumping water), ships' hulls, anchors, navigational buoys, drilling platforms, and floating marine debris, are also important. Other pathways include intentional and unintentional human introductions of fish and shellfish, and illegally released organisms from the aquaculture, aquarium, horticulture, and pet industries. There is increasing concern that an expanding trade through the Internet and dealers of exotic pets is exacerbating the invasive species problem, including the introduction of diseases.<sup>8</sup>

### **Ballast Water**

Ships carry ballast water to aid in stability, trim (or balance), and structural integrity. An estimated 7,000 species are carried in ships' ballast tanks around the world.<sup>9</sup> While most of them perish during the voyage, even a few survivors can be enough to establish a reproductive population when discharged into a waterway. Under certain conditions, the new population can compete with native species and become pests in their new environment.

Currently, ships entering U.S. waters with no ballast on board are exempt from some management requirements. However, even seemingly empty ballast tanks often contain residual water and sediments that can release non-native species to receiving waters when the ships later take on and discharge water during a coastal or Great Lakes passage.

## Global Trade in Marine Organisms

Human releases of living marine resources serve as another pathway for invasive species. Live fish and shellfish importers, aquaculture facilities (Chapter 22), and retail pet stores routinely transport, raise, and sell non-native species in the course of business. Along the way, specimens can escape, be disposed of in an unsafe manner, or unknowingly serve as a vector for the introduction of other organisms. Live worms and other bait, packing material, seaweed, and the very seawater used to transport living organisms may also introduce non-native species into new environments.<sup>10</sup>

## MAKING PREVENTION THE FIRST LINE OF DEFENSE

Recognizing the economic and biological harm caused by invasive species, and acknowledging the difficulty of eradicating a species once it is established, aggressive steps should be taken to prevent such introductions.

### Ballast Water Management

Exchanging ballast water in the middle of the ocean to reduce the risk of transferring organisms from one ecosystem to another is the primary management tool currently available for ships to control the introduction of invasive species.

The U.S. Coast Guard began implementing ballast water management regulations in 1993 and mandated ballast water exchange for vessels bound for the Great Lakes. However, the lack of similar requirements across the nation led several states, including California, Oregon and Washington, to also make ballast water exchange mandatory for ships entering their state waters. As a result, ships entering U.S. waters have to contend with different requirements depending on their port of entry. To strengthen invasive species management, the Coast Guard is finalizing regulations mandating ballast water exchange nationwide.

However, new technologies may also provide alternatives to mid-ocean ballast water exchange by finding ways to eliminate stowaway species in ballast water. To encourage development, testing, and adoption of these technologies, the Coast Guard is establishing an enforceable treatment standard and a shipboard testing program. This approach will ensure a required level of protection against the spread of nonindigenous species and speed progress toward an ultimate goal of preventing all introductions of organisms, including bacteria and viruses.

**Recommendation 17–1. The U.S. Coast Guard’s national ballast water management program should: apply uniform, mandatory national standards; incorporate sound science in the development of a biologically meaningful and enforceable ballast water treatment standard; include a process for revising the standard to incorporate new technologies; ensure full consultation with the U.S. Environmental Protection Agency, both during and after the program’s development; and include an interagency review, through the National Ocean Council, of the policy for ships that declare they have no ballast on board.**

Investments in new treatment technologies, including technologies to minimize the uptake of sediments in ships’ ballast tanks, will help avoid the high cost of managing new invaders. Although NANPCA directed DOI and NOAA, in cooperation with the Coast Guard, to conduct projects that demonstrate technologies and practices for preventing introductions through ballast water, Congress has historically underfunded this program. The current limited program supports some technology development, but is unable to demonstrate the real-world effectiveness of these technologies for treating ballast water. To ensure ongoing improvements, government and industry will need to work together to develop and test innovative treatment technologies that are environmentally and economically viable.

**Recommendation 17-2. The National Ocean Council should commission a credible, independent, scientific review of existing U.S. ballast water management research and demonstration programs and make recommendations for improvements.**

*The review should consider the following issues:*

- *how federally funded research and demonstration programs can best promote technology development, support on-board ship testing, and move technologies from research to commercial use.*
- *what is the best role is for industry and how industry can be engaged in onboard testing of experimental ballast water management technologies.*
- *what kind of peer review process is needed for scientific oversight of technology development, selection of demonstration projects, and testing of experimental treatment systems.*
- *what an adequate funding level for a successful program would be.*

### **Controlling Other Pathways**

Ballast water is a clearly identifiable source that can be managed through traditional regulatory means, but other sources of non-native species, such as the shellfish importing, aquaculture, aquarium, horticulture, and pet industries, are far more diffuse and less amenable to federal controls. Preventing introductions through these pathways will require a mix of federal and state legislation and public education.

Public education is a vital component of a prevention strategy. Individuals must understand that their actions can have major, potentially irreversible, economic and ecological consequences. Increasing the public's awareness, and suggesting actions that boaters, gardeners, scuba divers, fisherman, pet owners, and others can take to reduce introductions, can help prevent the spread of invasive species.

Currently, a number of unconnected education and outreach programs exist—generally focusing on individual species—but a more coordinated, national plan is needed. As international markets continue to open and Internet use grows, access to the purchase and importation of non-native animals and plants from all over the globe is likely to increase. Some industry representatives have expressed concern that efforts to ban unwanted species and otherwise prevent introductions of non-native species may interfere with the flow of free trade and the need to protect public health and ecosystems will have to be balanced against these individual interests.

**Recommendation 17–3. The National Ocean Council, working with the Aquatic Nuisance Species Task Force and the National Invasive Species Council, should coordinate public education and outreach efforts on aquatic invasive species, with the aim of increasing public awareness about the importance of prevention.**

*This coordinated education effort should:*

- *connect local, regional, and national outreach and education efforts, including recommendations from the U.S. Invasive Species Management Plan and programs initiated by various industries that deal with non-native species.*
- *target the public, importers and sellers, pet store and restaurant owners, divers, and others with information about the harm caused by invasive species and safe methods of shipping, owning, and disposing of exotic species.*
- *require the aquaculture, horticulture, pet, and aquarium industries to clearly communicate to their customers the hazards of releasing non-native species.*



## ACCELERATING DETECTION AND RESPONSE

Only the most draconian prevention strategy could hope to eliminate all introductions of non-native species and thus prevent the possibility of an invasion. Yet no effective mechanism is in place for rapidly responding to newly discovered aquatic invasions when they do occur. Currently, both states and regional panels are encouraged to develop detection and rapid response plans; however jurisdictional questions and limited resources have hindered development and implementation of such plans.

Of the approximately \$149 million in federal funding spent in 2000 for invasive species rapid response, the U.S. General Accounting Office (GAO) estimates that USDA spent about \$126 million on threats to crops and livestock.<sup>11</sup> In contrast, DOI, USGS, and NOAA collectively spend about \$600,000 annually on responses to threats from aquatic species. The inadequacy of this funding level becomes even more obvious when the costs of a single eradication effort are considered.

In June 2000, *Caulerpa taxifolia*, dubbed a “killer algae,” was discovered near a storm drain in the Agua Hedionda Lagoon in southern California. Efforts to eradicate the algae, primarily injections of chlorine under tarps placed over the infested areas, were overseen by the Southern California Caulerpa Action Team. The initial eradication effort cost \$500,000, with another \$500,000 allocated for surveys and treatment of remaining infestations. The eradication efforts will not be deemed successful until five years pass, during which an average of more than \$1 million will be spent annually for periodic surveying and spot treatments.<sup>12</sup>

Other examples abound. Control of the invasive zebra mussel, an organism first introduced through ballast water discharge, cost municipalities and industries almost \$70 million a year between 1989 and 1995.<sup>13</sup> Over the next ten years, the zebra mussel invasion will cost an estimated \$3.1 billion including costs to industry, recreation, and fisheries. Florida’s ongoing cost to manage the non-native hydrilla plant is more than \$17 million a year.<sup>14</sup>

**Recommendation 17–4. The National Invasive Species Council and the Aquatic Nuisance Species Task Force, working with other appropriate entities, should establish a national plan for early detection of invasive species and a system for prompt notification and rapid response. Congress should provide adequate funding to support the development and implementation of this national plan.**

*The plan should:*

- *provide risk assessments of potentially harmful invaders and pathways of introduction.*
- *conduct a comprehensive national biological survey and monitoring program for early detection, building upon recent progress in this area by academia, the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, and the U.S. Environmental Protection Agency.*
- *determine the threshold needed to trigger a rapid response and develop environmentally sound rapid-response, eradication, and control actions.*
- *designate resources for implementing surveys and eradication programs.*
- *develop partnerships among government, industry and user groups to fund and implement response actions.*

## IMPROVING THE CONTROL OF INVASIVE SPECIES

As biological invasions continue, there is a pressing need to improve the control of invasive species by reducing the overlaps and redundancies caused by the involvement of so many agencies with insufficient interagency coordination. More than twenty federal entities, under ten departments or independent agencies, have some responsibility for invasive species management.



### Federal Departments and Agencies Involved in Invasive Species Activities

#### U.S. Department of Agriculture

Agriculture Research Service  
Animal and Plant Health Inspection Service  
Cooperative State Research, Education, and  
Extension Service  
Economic Research Service  
Farm Service Agency  
Forest Service  
Natural Resources Conservation Service

#### U.S. Department of Commerce

National Oceanic and Atmospheric  
Administration

#### U.S. Department of Defense

U.S. Army Corps of Engineers

#### U.S. Environmental Protection Agency

#### U.S. Department of Homeland Security

U.S. Coast Guard

#### U.S. Department of the Interior

Bureau of Indian Affairs  
Bureau of Land Management  
Bureau of Reclamation  
U.S. Fish and Wildlife Service  
U.S. Geological Survey  
Minerals Management Service  
National Park Service  
Office of Insular Affairs

#### National Science Foundation

#### Smithsonian Institution

#### U.S. Department of State

#### U.S. Department of Transportation

Federal Highway Administration

#### U.S. Department of the Treasury

### Coordinated Action

The Aquatic Nuisance Species Task Force and the National Invasive Species Council have made a start in coordinating federal agencies and states. Yet different priorities among the agencies constrain full cooperation in funding and implementing invasive species programs. The ability to establish cross-agency goals is limited, and neither the task force nor the Council has established clear performance-oriented objectives in their work plans.

Management of invasive species is particularly complicated because the initial source of the non-native species, the path of introduction, and the resulting ecological and economic impacts may be quite far removed from each other. This increases the need for close coordination among different jurisdictions. Although national standards are important for ballast water, coordinated regional or state actions may be more appropriate for other pathways. The task force does promote the development of state plans, but has had only marginal success in bringing resources to the regional panels and local authorities for implementation.

While most management plans focus on unintentional introductions, a noticeable gap in regulatory authority exists in the area of intentional introductions of non-native species for commercial purposes. A recent example is the controversial proposal to introduce a Chinese oyster (*Crassostrea ariakensis*) into the Chesapeake Bay to replace the vanishing native oyster and revive the moribund oyster industry there. A 2003 National Research Council report concluded that a rigorous, consistent risk assessment protocol will be needed to evaluate such proposals, but there is currently no authority or mechanism for conducting such assessments.<sup>15</sup>

Clearer policies will also be necessary as the aquaculture industry expands (Chapter 22). Voluntary self-regulation by participants in the aquaculture industry is likely to be ineffective because the costs of control are relatively high, it is difficult to trace an introduced species to a specific source, and the negative consequences of an introduction fall on outsiders.

**Recommendation 17–5. The National Ocean Council (NOC) should review and streamline the current proliferation of federal and regional programs for managing marine invasive species, and coordinate federal, regional and state efforts. Coordinated plans should be implemented to develop risk assessment and management approaches for intentional and unintentional species introductions that minimize the potential of invasions at the lowest cost.**

*Specifically, the NOC should:*

- *review the effectiveness of existing programs and legal authorities and clarify the lines of responsibility and enforcement authority, including responsibility for intentional introductions of non-native species.*
- *develop long-term goals and measures for evaluating effective performance.*
- *support increased funding for agencies responsible for preventing the introduction of invasive species, including support for regional and state programs.*
- *determine whether, in the long term, a single agency should be charged with preventing the entry of, monitoring, and containing invasive species in coastal and marine waters.*

## International Partnerships

The movement of invasive species is clearly a global concern, and successful programs will require strong international cooperation and coordination. In 2004, the International Maritime Organization (IMO) adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments, a new convention designed to control the spread of invasive species carried in ships' ballast water. The convention contains requirements for ship ballast water management, but also allows countries to establish additional, more stringent national or regional standards. The implications of this new convention for U.S. ballast water policy are currently under discussion. The United States should continue to pursue national legislative and regulatory remedies to limit ballast water introductions into the Great Lakes and U.S. coastal waters, while recognizing that international solutions provide the best long-term strategy for addressing the global threat presented by ships' ballast water.

The United States can work with its closest neighbors, Canada and Mexico, to develop a North American strategy, craft regional invasive species management programs, and encourage key commercial sectors to develop voluntary codes of conduct and other self-regulatory mechanisms. Based on national and regional experiences, the United States can then promote international progress through appropriate conventions and treaties.

**Recommendation 17–6. The United States should take a leading role in the global effort to control the spread of non-native aquatic species by working internationally to develop treaties, agreements, and policies to minimize the introduction and establishment of such species.**

## Research Needs

The study of marine biological invasions is a relatively new research area. Although invasive species have dramatically changed ecosystem structures, threatened native species, and caused hundreds of millions of dollars in economic damage, little is understood about how or why certain species become invasive, what pathways of introduction are most important, and whether certain factors make an ecosystem more

susceptible to invasions. Currently, U.S. investment in research about invasive species, monitoring to detect invasions, and development of new techniques for identification and eradication falls far short of the economic cost to the nation caused by this problem.

**Recommendation 17–7. The National Ocean Council should coordinate the development and implementation of an interagency plan for research and monitoring to understand and prevent aquatic species invasions. Congress should increase funding in this area to improve management decisions and avoid future economic losses.**

*New research and monitoring efforts should focus on:*

- *gathering baseline taxonomic information and strengthening taxonomic skills; performing quantitative assessments of ecosystems; identifying invasive pathogens and vectors of introduction; and determining how invasive species disrupt ecosystem functions.*
- *understanding the human dimensions behind species introductions (human behavior, decision making, and economics).*
- *developing new options for minimizing invasions, including innovative technologies, and translating these findings into practical policy options for decision makers.*

<sup>1</sup> Butman, C. A., and J. T. Carlton. *Understanding marine biodiversity: A research agenda for the nation*. National Research Council. Washington, DC: National Academy Press, 1995.

<sup>2</sup> Carlton, J. T. *The scale and ecological consequences of biological invasions in the world's oceans*. O. T. Sandlund, P. J. Schei, and A. Viken, editors, *Invasive Species and Biodiversity Management*. Pp. 195-212. 1999. Kluwer Academic Publishers, Dordrecht, Netherlands.

<sup>3</sup> Pimentel, D., et al. "Environmental and Economic Costs of Nonindigenous Species in the United States." *Bioscience* 50, no. 1 (2000): 53–65.

<sup>4</sup> U.S. General Accounting Office. *Invasive Species: Clearer Focus and Greater Commitment Needed to Effectively Manage the Problem*. Report GAO-03-1. Washington, DC, 2002.

<sup>5</sup> Naylor, R.L., S.L. Williams, and D.R. Strong. "Aquaculture: A Gateway for Exotic Species." *Science* 269 (2001): 1655–56.

<sup>6</sup> Bureson, E.M., N.A. Stokes, and C.S. Friedman. "Increased Virulence in an Introduced Pathogen: *Haplosporidium nelsoni* (MSX) in the Eastern Oyster *Crassostrea virginica*." *Journal of Aquatic Animal Health* 12 (2000): 1–8.

<sup>7</sup> National Invasive Species Council. Meeting the Invasive Species Challenge. National Invasive Species Council Management Plan. 2001.

<sup>8</sup> Lodge, D.M. "Biological Hazards Ahead." *New York Times*, June 19, 2003.

<sup>9</sup> International Maritime Organization. "Global Ballast Water Management Programme—The Problem." <<http://globallast.imo.org/index>> Accessed October 1, 2003.

<sup>10</sup> U.S. General Accounting Office. *Invasive Species: Obstacles Hinder Federal Rapid Response to Growing Threat*. Report GAO-01-724. Washington, DC, July 2001.

<sup>11</sup> Ibid.

<sup>12</sup> Anderson, L.W.J., U.S. Department of Agriculture, Agricultural Research Service, Weed Science Program. Personal communication to the U.S. Commission on Ocean Policy. July 21, 2003.

<sup>13</sup> U.S. General Accounting Office. *Invasive Species: Obstacles Hinder Federal Rapid Response to Growing Threat*. Report GAO-01-724. Washington, DC: July 2001.

<sup>14</sup> Florida Department of Environmental Protection, Bureau of Invasive Plant Management. *Status of the Aquatic Plant Management Program in Florida Public Waters: Annual Report, Fiscal Year 2001–2002*. Tallahassee, FL, 2003.

<sup>15</sup> National Research Council. *Non-native Oysters in the Chesapeake Bay*. Washington, DC: National Academy Press, 2003.



## CHAPTER 18: REDUCING MARINE DEBRIS

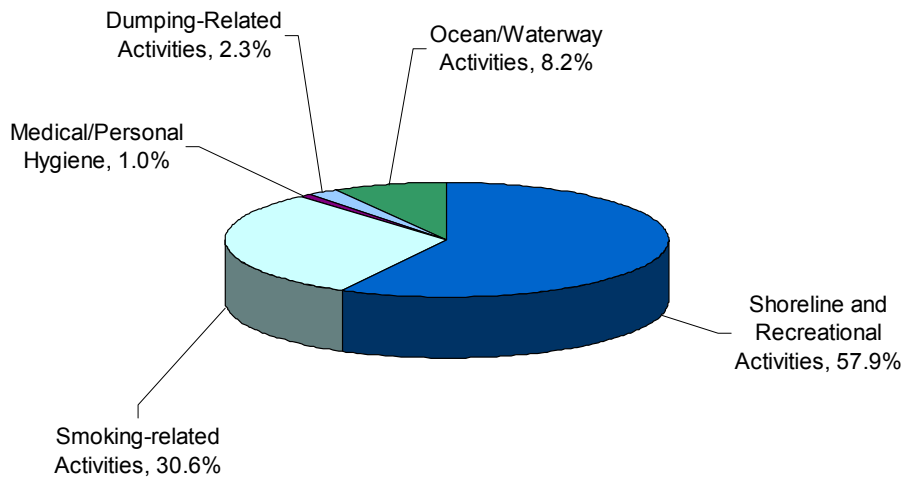
*The trash and other waste that drifts around the global ocean and washes up on the nation's shores poses a serious threat to fishery resources, wildlife, and habitat, as well as human health and safety. Marine debris is difficult to address because it comes from a wide variety of sources, both on and off the shore. While marine debris is a global problem requiring international cooperation, many of its negative impacts are experienced at the local level and require local involvement. Because of its role as the nation's lead ocean agency, re-establishing a marine debris program within the National Oceanic and Atmospheric Administration would help address the range of issues associated with marine debris, as would better coordination at all scales—international, national, state, and local. Greater commitment to public education and outreach, partnerships with local governments, communities, and industry, and enhanced research, monitoring, and source identification will also help reduce marine debris.*

### ASSESSING THE SOURCES AND CONSEQUENCES OF MARINE DEBRIS

Most trash has the potential to become marine debris; cigarette filters, plastic bags, bottles, cans, and straws can all be found scattered along beaches and in the oceans. Marine debris degrades slowly and is buoyant, often traveling for thousands of miles in ocean currents. Approximately 80 percent of debris is washed off the land, blown by winds, or intentionally dumped from shore, while 20 percent comes from vessels and offshore platforms.<sup>1</sup>

Shoreline and recreational activities were sources of the majority of debris found during the 2002 International Coastal Cleanup (Figure 18.1).<sup>2</sup> Litter associated with cigarette smoking was the second largest source. Ocean-based activities, including cruise ship operations, commercial fishing, recreational boating, commercial shipping, military vessel operations, and offshore oil drilling, were also a significant source of debris. Cargo lost overboard from freighters poses another concern. Large containers have broken open and released their contents—including everything from sneakers to computer monitors—into the ocean.

**Figure 18.1. Trash Buildup at the Beach**



In 2002, more than 8.2 million pounds of debris were collected and analyzed as part of a worldwide beach cleanup effort. The largest source of marine debris was from land-based human activities; shoreline and recreational activities alone contributed almost 58 percent of the number of items collected. Beaches yielded over 1 million cigarette butts, 444,000 food wrappers or containers, 220,000 bottles, 190,000 plastic bags, 32,000 pieces of fishing line, and 8,000 tires.

Source: The Ocean Conservancy. *The 2002 International Coastal Cleanup*. Washington, DC, 2003.

Marine debris threatens wildlife through entanglement and ingestion. A 1997 study found that at least 267 species have been affected by marine debris worldwide, including 86 percent of all sea turtle species, 44 percent of all seabird species, and 43 percent of all marine mammal species, as well as numerous fish and crustaceans.<sup>3</sup> Entanglement can wound animals, impair their mobility, or strangle them. Birds, sea turtles, and marine mammals can swallow debris such as resin pellets, convenience food packaging, and plastic bags, which interfere with their ability to eat, breathe, and swim. Sea turtles often ingest floating plastic bags, mistaking them for jellyfish. “Ghost fishing”—entanglement of fish and marine mammals in lost fishing gear—represents a serious threat to marine life, including endangered species such as Hawaiian monk seals and North Atlantic right whales.

Coral reefs, seagrass beds, and other fragile coastal habitats have been harmed by trash in the oceans. Derelict fishing gear, pushed by wind and waves, can become snagged on coral reefs and other structures. This global problem is particularly evident in the Northwest Hawaiian Islands, which include 69 percent of all U.S. coral reefs by area. Floating debris can also transport non-native, potentially invasive species over long distances.

### **Abandoned Fishing Nets Catch a Wave to Hawaii**

The two most prevalent types of nets recovered in the Northwest Hawaiian Islands (measured by weight) are trawling nets and monofilament gill nets, despite the fact that no commercial trawl or gillnet fisheries exist in the area.<sup>4</sup> The nets are carried to the islands via ocean currents from domestic and foreign fisheries in the North Pacific. Finding a solution to the problem of derelict fishing nets and other gear will require international cooperation.

Marine debris also has significant consequences for people. Broken glass and medical waste on beaches, as well as ropes and lines dangling in the ocean, pose threats to beachgoers, boaters, and divers. Debris can damage boats and strand their occupants when propellers become entangled on lines, or engines stall when plastic bags are sucked into intake pipes. Beach closures and swimming advisories due to marine debris can



have direct economic impacts by reducing coastal tourism. For example, New Jersey lost an estimated \$2 billion in tourist revenue as a result of debris washing ashore in the 1987 and 1988 beach seasons. The state has chosen to invest \$1.5 million annually in beach cleanup to avoid similar losses in the future.<sup>5</sup>

## ADDRESSING MARINE DEBRIS NATIONALLY

### Existing Programs

Efforts to reduce marine debris must take place at all levels, from international to local. Internationally, marine debris is addressed by Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL), which prohibits all overboard disposal of plastics and limits other discharges based on the material and the vessel's location and distance from shore. The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (known as the London Convention) is another international agreement that addresses the problems of marine debris. Domestically, a number of federal laws focus on marine debris, including the Act to Prevent Pollution from Ships (which prohibits the disposal of all garbage within 3 nautical miles of the coast and enforces Annex V of MARPOL), the Marine Plastic Pollution Research and Control Act, the Clean Water Act, Title I of the Marine Protection, Research, and Sanctuaries Act (commonly referred to as the Ocean Dumping Act), the Beaches Environmental Assessment and Coastal Health Act, and the Shore Protection Act. (Appendix D includes a summary of these and other ocean-related federal laws.) Some states also have their own laws to address marine debris.

Reductions in marine debris have been the focus of a number of agency initiatives and volunteer efforts, ranging from local adopt-a-beach programs to international beach cleanups. The Ocean Conservancy, a nonprofit ocean advocacy group, coordinates the annual International Coastal Cleanup campaign with support and funding from the U.S. Environmental Protection Agency (EPA) and private and corporate foundations. The one-day event takes place in September, with volunteers from all over the world collecting trash along the coasts and in the oceans. Since its inception in 1986, the campaign's original 2,800 volunteers have grown to almost 392,000 in 2002.

From 1986 to 2002, the International Coastal Cleanup removed 89 million pounds of debris from more than 130,000 miles of shoreline. Starting in 1995, more than 108,000 divers also collected 2.2 million pounds of trash in over 3,900 miles of underwater habitat.<sup>6</sup> The program is effective not only because of the visibility it receives as the largest single-day volunteer event for the marine environment, but also because of the amount of data collected during the event. Debris collection results are posted by source, calling attention to the activities that create the most debris with the hope of improving prevention.

The vast data collection potential demonstrated during International Coastal Cleanup events led to development of the National Marine Debris Monitoring Program, implemented by The Ocean Conservancy with EPA funding. This program is designed to systematically assess the success of Annex V of MARPOL by identifying sources and trends of marine debris. Volunteers at 180 randomly selected study sites along the U.S. coast collect and submit monthly information on the incidence of thirty specific marine debris items.

EPA and The Ocean Conservancy also created the Storm Drain Sentries program in response to research indicating that storm drains are significant sources of marine pollution. This program raises public awareness of the consequences of dumping trash and other pollutants into sewer systems. Volunteers stencil storm drains with educational messages and collect information on the types of contaminants found around storm drains.

The Coral Reef Ecosystem Investigation is a multi-agency program, headed by the National Oceanic and Atmospheric Administration (NOAA), to assess, monitor, and mitigate the impact of marine debris on coral reef ecosystems of the U.S. Pacific Islands. The Coral Reef Ecosystem Investigation began as a pilot study in

1996, primarily to remove fishing gear in and around Hawaiian monk seal habitat. Since then, the program has grown to involve a number of federal, state, local, nongovernmental, and private partners in the large-scale removal of marine debris, including derelict fishing gear.

### **NOAA's Role**

Concerns about marine debris came to public attention during the 1980s, with mounting evidence of entanglement or other harm to marine mammals, sea turtles, birds, and fish. In 1985, Congress appropriated \$1 million in funding for the development of a comprehensive marine debris research and management program (which became the Marine Entanglement Research Program), directed by NOAA in consultation with the U.S. Marine Mammal Commission. In 1995, a report by the National Research Council called for a long-term program to monitor the flux of plastics to the oceans and noted that NOAA would be best suited to lead such a monitoring effort.<sup>7</sup> Despite this recommendation—and the ongoing problem of marine debris—the Marine Entanglement Research Program ended in 1996.

Although EPA has some programs to address marine debris (described above), the problem of marine debris is more closely related to NOAA's mission and management responsibilities, including fisheries, marine mammals, endangered marine species, beach and shoreline management, and coral reefs. While NOAA currently addresses marine debris as a part of several other efforts, there is a need to coordinate, strengthen, and increase the visibility of the marine debris efforts within NOAA by creating a clear, centralized marine debris program within the agency.

### **Recommendation 18–1. The National Oceanic and Atmospheric Administration should establish and support a marine debris management program.**

This program should be closely coordinated with EPA's marine debris activities, as well as with the significant efforts conducted by private citizens, state, local, and nongovernmental organizations. In the future, the National Ocean Council should examine whether marine debris efforts would benefit from consolidation within a single agency.

### **Interagency Coordination**

The Marine Plastic Pollution Research and Control Act of 1987 established an interagency marine debris coordinating committee with membership comprised of senior officials from NOAA, EPA, the U.S. Coast Guard, and the U.S. Navy. The committee was charged with furthering public outreach, education, and information sharing efforts. However, Congress allowed the committee to lapse in 1998, and it has not been re-established.

Although strengthening NOAA's work on marine debris through establishment of an office within the agency is an important step, an interagency committee under the National Ocean Council will still be needed to unite all appropriate federal agencies around the issue. Such a committee could support existing marine debris efforts by agencies and nongovernmental organizations. Potential functions for the committee are described below.

#### ***Education and Outreach***

While existing public education and cleanup initiatives have made a substantial contribution to improving the ocean environment, the volumes of trash that continue to appear on beaches and in the oceans indicate that many people and communities have not yet changed their behavior. Many people consider their actions to be negligible when compared with those of large-scale polluters; however, the cumulative impact of continuous,

small-scale insults can be significant. Although items such as plastic bags, rope, and six-pack holders do not comprise the majority of the debris, they are extremely dangerous for marine life. Thus a significant opportunity to reduce marine debris comes from educating the public. (Public education and outreach opportunities are addressed in greater detail in Chapter 8.)

Because comprehensive monitoring and enforcement of individual behavior would be impossible, people should be given the knowledge, training, and motivation to voluntarily change their behavior. Public education campaigns should clearly convey that individual actions have cumulative impacts and should involve the tourism industry and other nontraditional participants, such as packaging companies and local government officials.

### ***Working with Communities***

Cigarette filters, food wrappers, caps, and lids accounted for nearly half of all debris collected in the 2002 International Coastal Cleanup. For the past thirteen years, cigarette filters have been the most commonly found debris item.<sup>8</sup> It is apparent that implementation and enforcement of local anti-litter regulations have been inadequate.

Not only is trash left on beaches and shores, allowing it to wash into the oceans, litter is also washed off streets and parking lots, and through storm drains far inland. People generally have not made the connection between actions taken far from the coast and their impacts on the shore and ocean areas.

While public education can send the message not to litter, active management of debris entering and exiting sewer systems can also be improved by adding controls for local sewer systems, such as screens and netting, and making catch-basin modifications. Floatable controls can help reduce or eliminate solid waste emitted from sewer systems. Placing sufficient trash receptacles throughout communities can also make it easier for people to dispose of the materials that might otherwise end up in the marine environment.

### ***Working with Industry***

Cooperation with industry, particularly companies whose products are ending up on the shores and in the oceans, presents another opportunity to reduce marine debris. The Coca-Cola Company, Dow Plastics, and Philip Morris are all examples of companies that have helped sponsor the International Coastal Cleanup. Morton Salt, the maker of products used by many commercial shrimp boats to treat their catches at sea, took action after blue plastic bags with the Morton Salt label started washing up on Gulf of Mexico beaches. Since the company started printing reminders like “Stow It, Don’t Throw It” on the bags, fewer Morton Salt bags have been reported as washing up on shores.<sup>9</sup>

Working in concert with the U.S. Department of the Interior’s Minerals Management Service, the offshore petroleum industry has instituted marine debris education training for personnel working on offshore platforms, mobile drilling rigs, and other facilities in the Gulf of Mexico. This initiative requires the posting of marine debris reminder signs and the mandatory viewing by all personnel of a film demonstrating proper waste disposal practices and the impacts of marine debris on the ocean.

Plastics comprise about 60 percent of the trash found on beaches<sup>10</sup> and about 90 percent of debris found floating in the water.<sup>11</sup> Industry support for reducing plastic trash and encouraging greater recycling rates could reduce the amount of litter reaching the coasts and oceans. Fishing gear manufacturers could also play a role in educating fishing vessel owners and crews about the impacts of derelict gear.

### ***Source Identification, Monitoring, and Research Efforts***

The implementation of effective control measures is currently hampered by a lack of consistent monitoring and identification of sources of debris. A 1995 National Research Council report found that most available data are obtained from beach surveys, with relatively little information on debris that ends up in the sea or on the seabed.<sup>12</sup> Collection of such data would require a systematic, international effort. Information about the behavior of debris in the marine environment and its ecological effects is even scarcer. These effects cannot be established simply on the basis of available surveys, due primarily to the absence of a common framework for data collection, centralized data analysis, and information exchange. Once a framework and suitable information protocols are in place, these data should be linked with the national Integrated Ocean Observing System (discussed in Chapter 26).

**Recommendation 18–2.** The National Ocean Council should re-establish an interagency marine debris committee, co-chaired by the U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration. The committee should work to expand and better coordinate national and international marine debris efforts, including: public outreach and education; partnerships with local government, community groups, and industry; monitoring and identification; and research.

## **ELIMINATING DERELICT FISHING GEAR**

One source of marine debris that requires special attention is derelict fishing gear. Whether intentionally discarded or unintentionally lost during storms or fishing operations, derelict fishing gear poses serious threats, entrapping marine life, destroying coral reefs and other habitat, and even posing danger to humans. Currently, almost all of the fishing nets used outside of subsistence fisheries are made of synthetic fibers that are highly resistant to degradation.<sup>13</sup> Although derelict fishing gear is a worldwide problem, currently no international treaties or plans of action address it.

**Recommendation 18–3.** The U.S. Department of State and National Oceanic and Atmospheric Administration, working with the United Nations Food and Agriculture Organization and other appropriate entities, should develop a detailed plan of action to address derelict fishing gear, to be implemented on a regional, multi-national basis.

Within the United States, a public–private partnership program is needed to prevent, remove, and dispose of derelict fishing gear. Some options include imposing a fee on the manufacture of nets to pay for their recovery, attaching locator devices to gear, providing incentives for industries that are developing biodegradable fishing gear, and providing compensation for the expense of bringing discarded gear to shore.

**Recommendation 18–4.** The National Oceanic and Atmospheric Administration should promote a public-private partnership program and implement strong incentives for removal and disposal of derelict fishing gear.

## **ENSURING APPROPRIATE PORT RECEPTION FACILITIES**

Annex V of MARPOL contains several provisions that address marine debris. Under its requirements for port reception facilities, member nations must provide waste disposal facilities in their ports to receive waste from ships. Despite this requirement, many ports do not have adequate facilities. In addition, Annex V calls for the designation of Special Areas that receive a higher level of protection than is required in other ocean areas. Special Areas have been designated for many parts of the world, including areas of the Mediterranean, Baltic, Black, Red, and North Seas, the Antarctic, and the Wider Caribbean region, which includes the Gulf of

Mexico and the Caribbean Sea. However, for a Special Area to receive extra protection, there must first be a demonstration of adequate port reception facilities. Once these facilities have been verified, the International Maritime Organization establishes a date for Special Area protections to enter into force. Some important Special Areas, such as the Wider Caribbean, are not yet eligible to receive extra protection because of inadequate port reception facilities.

**Recommendation 18–5.** The U.S. Department of State should increase efforts to ensure that all port reception facilities meet the criteria necessary to allow implementation of Special Areas protections under Annex V of the International Convention for the Prevention of Pollution from Ships.

<sup>1</sup> U.S. Department of Commerce and U.S. Navy. *Turning to the Sea: America's Ocean Future*. Washington, DC, September 1999.

<sup>2</sup> The Ocean Conservancy. *2002 International Coastal Cleanup*. Washington, DC, 2003.

<sup>3</sup> Laist, D.W. "Impacts of Marine Debris: Entanglement of Marine Life in Marine Debris, Including a Comprehensive List of Species with Entanglement and Ingestion Records." In *Marine Debris: Sources, Impacts and Solutions*, ed. J.M. Coe and D.B. Rogers. New York, NY: Springer-Verlag, 1997.

<sup>4</sup> U.S. Department of State. *Promotion of Implementation and Enforcement of MARPOL 73/78 and Related Codes. MARPOL Annex V and Marine Debris*. London, England: International Maritime Organization, 2001.

<sup>5</sup> National Oceanic and Atmospheric Administration. "Perspectives on Marine Environmental Quality." In *Year of the Ocean Discussion Papers*. Washington, DC, 1998.

<sup>6</sup> The Ocean Conservancy. *2002 International Coastal Cleanup*. Washington, DC, 2003.

<sup>7</sup> National Research Council. *Clean Ships, Clean Ports, Clean Oceans: Controlling Garbage and Plastic Wastes at Sea*. Washington, DC: National Academy Press, 1995.

<sup>8</sup> The Ocean Conservancy. *2002 International Coastal Cleanup*. Washington, DC, 2003.

<sup>9</sup> *Ibid.*

<sup>10</sup> U.S. Department of Commerce and U.S. Navy. *Turning to the Sea: America's Ocean Future*. Washington, DC, September 1999.

<sup>11</sup> United Nations Environment Program, Global Programme of Action Coordination Office; Swedish Environmental Protection Agency; and United Nations International Maritime Organization. "Marine Litter—What & Where?" <<http://marine-litter.gpa.unep.org/facts/what-where.htm>> Accessed November 2, 2003.

<sup>12</sup> National Research Council. *Clean Ships, Clean Ports, Clean Oceans: Controlling Garbage and Plastic Wastes at Sea*. Washington, DC: National Academy Press, 1995.

<sup>13</sup> U.S. Department of State. *Promotion of Implementation and Enforcement of MARPOL 73/78 and Related Codes. MARPOL Annex V and Marine Debris*. London, England: International Maritime Organization, 2001.

