U.S. COMMISSION ON OCEAN POLICY

PRELIMINARY REPORT

OF THE U.S. COMMISSION ON OCEAN POLICY

GOVERNORS' DRAFT
APRIL 2004

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GOVERNORS' DRAFT, WASHINGTON, D.C., APRIL 2004

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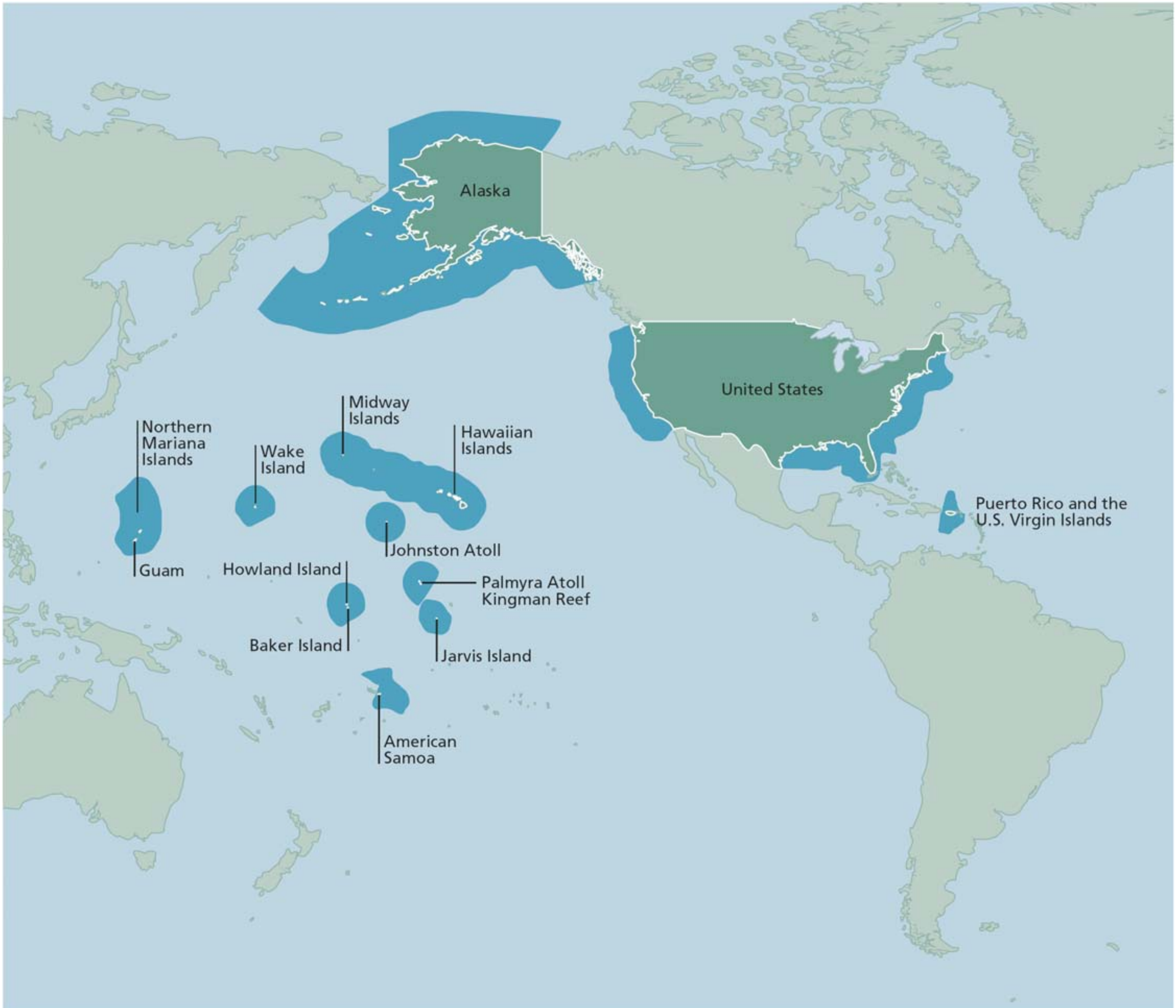

The United States Is an Ocean Nation

The U.S. exclusive economic zone (EEZ) extends 200 nautical miles offshore, encompassing diverse ecosystems and vast natural resources, such as fisheries and energy and other mineral resources. The U.S. EEZ is the largest in the world, spanning over 13,000 miles of coastline and containing 3.4 million square nautical miles of ocean, which is larger than the combined land area of the fifty states. (A square nautical mile is equal to 1.3 square miles.)

U.S. COMMISSION ON
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April 2004

Dear Reader:

As mandated by the *Oceans Act of 2000* (P.L. 106-256), the U.S. Commission on Ocean Policy is pleased to present this Preliminary Report for review by the nation's Governors and interested stakeholders. Detailed instructions for submitting comments, including the comment deadline, can be found on our Web site, www.oceancommission.gov. Higher quality, full-color versions of the graphics (tables, charts, and maps) can also be viewed at that site.

Beginning in September 2001, the Commission convened a series of fifteen public meetings and seventeen site visits around the country. The Commission members learned firsthand about the most pressing issues facing the nation regarding the use and stewardship of ocean and coastal resources. This Preliminary Report builds on information presented at those meetings, combined with the latest scientific and technical information on oceans and coasts, and inputs from hundreds of experts. This draft remains a work in progress. Nevertheless, the findings and policy recommendations included here reflect a consensus of the Commission members, and what they believe to be a balanced approach to protecting the marine environment while sustaining the vital role oceans and coasts play in our lives and national economy.

The release of this Preliminary Report is the first stage in our process. After careful consideration of comments received from the Governors and others, the Commission will deliver its final report to the President and Congress.

We welcome your thoughts and comments on this document. We believe the Commission's report will be essential in improving the nation's ocean and coastal policies and guaranteeing sustainable use of the world's oceans for the 21st century.

Sincerely,

James D. Watkins
Admiral, U.S. Navy (Retired)
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U.S. COMMISSION ON
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The Commission is deeply grateful to the many individuals who provided testimony, technical input, insightful comments, and many other forms of assistance in completing this momentous task.

A complete record of testimony presented to the Commission can be found in Appendices 1 and 2 and on the Commission's Web site (www.oceancommission.gov).

The many other contributors will be listed and acknowledged in the Commission's final report.

EXECUTIVE SUMMARY

The oceans affect and sustain all life on Earth. They drive and moderate weather and climate, provide us with food, transportation corridors, recreational opportunities, pharmaceuticals and other natural products, and serve as a national security buffer. But human beings also influence the oceans. Pollution, depletion of fish and other living marine resources, habitat destruction and degradation, and the introduction of invasive non-native species are just some of the ways people harm the oceans, with serious consequences for the entire planet.

The oceans provide tremendous value to our national economy. Annually, the nation's ports handle more than $700 billion in goods, and the cruise industry and its passengers account for $11 billion in spending. The commercial fishing industry's total value exceeds $28 billion a year, the recreational saltwater fishing industry is valued at around $20 billion, and the annual U.S. retail trade of ornamental fish is worth another $3 billion. The offshore oil and gas industry's annual production is valued at $25–$40 billion, and its yearly bonus bid and royalty payments contribute approximately $5 billion to the U.S. Treasury.

Every year, hundreds of millions of Americans and international visitors flock to the coasts to enjoy the oceans, spending billions of dollars and directly supporting more than a million and a half jobs. In fact, tourism and recreation constitute some of the fastest-growing business sectors—enriching economies and supporting jobs in communities virtually everywhere along the coasts of the continental United States, southeast Alaska, Hawaii, and our island territories and commonwealths.

These concrete, quantifiable contributions to the national economy are just one measure of the oceans' value. We also love the oceans for their beauty and majesty, and for their intrinsic power to relax, rejuvenate, and inspire. Unfortunately, we are starting to love our oceans to death.

The last comprehensive review of U.S. ocean policy took place more than 30 years ago when a governmental panel, the Stratton Commission, issued its report, *Our Nation and the Sea*. Since then, considerable progress has been made in many areas, but much work remains. In the last 30 years more than 37 million people, 19 million homes, and countless businesses have been added to coastal areas. Offshore oil and gas operations have expanded into deeper waters and improved their technologies, the country is ever more dependent on marine transportation, and coastal recreation and tourism have become two of the top drivers of the national economy. These developments, however, come with costs, and we are only now discovering the extent of those costs in terms of depleted resources, lost habitat, and polluted waters.

When Congress passed the Oceans Act of 2000, it acknowledged the importance of the oceans to this country. Pursuant to that Act, the President appointed 16 members, drawn from diverse backgrounds, to the U.S. Commission on Ocean Policy. The Commission's charge was to establish findings and develop recommendations for a new comprehensive national ocean policy. As part of its process, the Commission received testimony—oral and written—from hundreds of people from across the nation.

The message was clear: major changes are urgently needed. Ocean management responsibilities are dispersed among a confusing array of agencies at the federal, state, and local levels. While new scientific understanding has taught us that natural systems are complex and interconnected, our decision-making and management systems have not been updated to address that complexity and interconnectedness. Better approaches and tools are also needed to gather data to understand the complex marine environment. Perhaps most important, people must understand the role the oceans have on their lives and livelihoods and the impacts they themselves have on the oceans.

As the result of significant thought and deliberation and the consideration of a wide range of potential solutions, the Commission presents this preliminary report containing bold and broad-reaching recommendations for reform—reform that needs to start now, while it is still possible to reverse distressing declines, seize exciting opportunities, and sustain the oceans and their valuable assets for future generations.

A Vision for the Future

To be effective, U.S. ocean policy should be grounded in an understanding of ecosystems, and our management approach should be able to account for and address the complex interrelationships among the ocean, land, air, and all living creatures, including humans, and consider the interactions among multiple activities that affect entire systems. An ecosystem-based management approach should overcome the challenges inherent in addressing complex issues that cross traditional jurisdictional boundaries, and it must be able to continually adapt to new scientific information and improved management tools.

Ecosystem-based Management
U.S. ocean and coastal resources should be managed to reflect the relationships among all ecosystem components, including human and nonhuman species and the environments in which they live. Applying this principle will require defining relevant geographic management areas based on ecosystem, rather than political, boundaries.

The existing fragmented system for managing our oceans and coasts is unable to meet these goals. The Commission has identified a number of needed changes based upon three fundamental and crosscutting themes: (1) creating a new national ocean policy framework to improve decision- making; (2) strengthening science and generating high-quality, accessible information to inform decision makers; and (3) enhancing ocean education to instill future leaders and informed citizens with a stewardship ethic.

Create a New National Ocean Policy Framework

- Improve federal leadership and coordination.
- Strengthen federal agency structure to enable effective implementation of national ocean policy and enhance the ability of agencies to address links among ocean, land, and air.
- Enhance opportunities for state, territorial, tribal, and local entities to develop regional goals and priorities, improve responses to regional issues, and improve coordination.

A New National Ocean Policy Framework to Improve Decision-Making

To improve decision-making and move toward an ecosystem-based management approach, the Commission recommends a new National Ocean Policy Framework. This framework consists of several components and is designed to produce strong, high-level leadership, more effective coordination of the many federal agencies with ocean management responsibilities, and strengthened involvement in decision-making at the state, territorial, tribal, and local levels.

National Ocean Council and Related Elements

A central component of the proposed National Ocean Policy Framework is the establishment, within the Executive Office of the President, of a National Ocean Council, chaired by an Assistant to the President and composed of all the cabinet secretaries and independent agency directors with ocean-related responsibilities. A Presidential Council of Advisors on Ocean Policy, consisting of nonfederal representatives from state, territorial, tribal, and local governments and nongovernmental, academic, and private sector entities with ocean interests, would also be created to ensure a formal structure for nonfederal input on ocean and coastal policy matters. A small Office of Ocean Policy would provide staff support. The Commission recommends that this structure be established immediately by Congress. Pending congressional action, the President should put this structure in place through an Executive Order.

Strengthened Federal Agency Structure

Improved federal coordination is necessary, but not sufficient to bring about the depth of change needed to modernize our ocean governance system. As part of the new National Ocean Policy Framework, the existing federal agency structure should be made less redundant, more effective, and better suited to an ecosystem-based management approach. As an initial step, the National Oceanic and Atmospheric Administration (NOAA) should be reconfigured and strengthened to better enable it to execute its many ocean- and coastal-related responsibilities. The second step will be consolidation of overlapping ocean and coastal programs where appropriate. Over the long-term, more fundamental changes to the federal agency structure will be needed that recognize the links among the ocean, land, and air and that support a unified approach to resource use and conservation.

Enhanced Opportunities for Regional Coordination

Improving the ability of state, territorial, tribal, and local entities to participate in ocean policy-making and implementation is another critical component of the National Ocean Policy Framework. Many of the nation's most pressing ocean and coastal issues are regional in nature and require input on planning and management by state and local policy makers and other relevant stakeholders. Therefore, one of the priority tasks for the National Ocean Council will be to establish and facilitate a flexible process for creating nonregulatory regional ocean councils, to start immediately as pilot projects in regions where interest and capacity are strong. These councils would improve the ability of regional interests to work with federal entities, respond to issues and opportunities that cross jurisdictional boundaries in a timely fashion, and address the connections and conflicts among watershed, coastal, and offshore resources and their uses.

Strong Science for Wise Decisions

Effective policies should be based on unbiased, credible, and up-to-date scientific information. This requires a significant investment, an adequate infrastructure for data collection and management, and the ability to effectively translate scientific findings into useful and timely information products for policy makers, managers, educators, and the public. High quality, accessible information is critical to making wise decisions about ocean and coastal resources and their uses to guarantee sustainable social, economic, and environmental benefits from the sea.

Strengthen Science

Over the past two decades, the declining health of our oceans and coasts has become evident. In those same two decades, however, federal investment in ocean research has stagnated, while funding for other scientific program areas has increased. Ocean research efforts have fallen from 7 percent of the total federal research budget 25 years ago to just 3.5 percent today. Insufficient ocean science funding in the United States, combined with increased capacity in other nations, has lessened U.S. pre-eminence in ocean research, exploration, and technology development. Chronic under-investment has left much of our ocean-related scientific infrastructure in woefully poor condition. Current funding is well below the level needed to take advantage of our

Strengthen Science and Meet Information Needs

- Improve scientific understanding of the ocean and coastal environment and ensure effective science-based measures to use, safeguard, and restore ocean and coastal resources.
- Enhance the nation's ability to observe, monitor, and forecast ocean and coastal conditions to better understand and respond to the interactions among oceanic, atmospheric, and terrestrial processes.

academic capacity, remain a world leader in ocean science and marine technology, and meet today's ocean and coastal information needs. Furthermore, as we move toward an ecosystem-based management approach, managers' requirements for additional scientific information will only grow.

The federal investment in ocean and coastal research must be significantly increased to at least double today's $650 million annual investment, over the next five years. Additional investments in technology development and ocean exploration are also needed.

Meet Information Needs

A strong commitment is needed to support and conduct high priority research and exploration, develop and enhance the needed technology, create ocean science infrastructure, and integrate data management facilities. One of the most important ways to fulfill this commitment is by implementing a national Integrated Ocean Observing System (IOOS), based on a backbone of coordinated, interconnected U.S. regional ocean observing systems and linked to the international Global Ocean Observing System. The IOOS will substantially advance our ability to observe, monitor, and forecast ocean conditions and will contribute significantly to global Earth observing capabilities. The information generated by the IOOS will have invaluable economic, societal, and environmental benefits, including improved warnings of coastal and health hazards, more efficient use of living and nonliving resources, safer marine operations, and a better understanding of climate change. Implementation of the IOOS will require a funding commitment by Congress, with a ramp-up from $138 million in start-up costs in fiscal year 2006 to $650 million annually to maintain the fully operational system in fiscal year 2010 and beyond. While these numbers may seem daunting, it has been estimated that implementing the IOOS will actually save the United States close to $1 billion a year through enhanced weather forecasts, improved resource management, and safer and more efficient marine transportation.

Data collection and scientific discovery are not enough. These finding must be translated into useful, timely, and relevant information products so that policy makers, managers, and others can make informed decisions. This will require planning and collaboration among federal, academic, and private sector data providers and various user communities.

Education – A Foundation for the Future

A strong and effective national ocean policy needs to be supported by a foundation of high-quality ocean education that promotes lifelong learning, an adequate and diverse workforce, informed decision-making, science literacy, and a sense of stewardship. At the federal level, strengthened national leadership, better coordination, and sustained investments are critical. In addition, all ocean-related federal agencies must take responsibility for promoting education and outreach as part of their mission.

Enhance Ocean Education

- Improve decision makers' understanding of the ocean.
- Cultivate a broad public stewardship ethic.
- Prepare a new generation of leaders on ocean issues.

In the nation's schools, students should be taught about the oceans and their connections to the entire Earth and to people and society. Ocean exploration and discovery should be used to engage students of all ages in learning and to promote math and science achievement. Undergraduate and graduate programs will need to be enhanced to produce the scientists, technicians, educators, and informed decision makers of the future. Beyond the classroom, informal education efforts must help cultivate a sense of stewardship by helping all individuals to recognize the value of the ocean to their own lives and how their actions affect the marine environment. At all levels and across all disciplines, ocean education should be enhanced so that we can protect and sustain our marine resources for today as well as tomorrow.

Taking Action for Change

Building on a foundation of recommendations for improved governance, stronger scientific information, and enhanced education, the Commission examined the breadth of issues included in its charge from Congress. As a result, this report contains recommendations that span the gamut of ocean and coastal issues, ranging from upstream areas to the depths of the ocean floor, from practical problem-solving for specific issues, to philosophical approaches that will guide us into the next century.

A few of the other significant challenges the Commission identified are described below, accompanied by a brief summary of the actions recommended to address them. Further details about these issues, as well as many others, can be found in the full report.

Enable managers to address the pressures of coastal development…
…to achieve both economic growth and healthy coasts and watersheds.

Challenge: The continuing popularity of coastal areas brings benefits and opportunities to coastal communities, but it also creates pressures that are felt most acutely along the coast. Increased development puts more people and property at risk from coastal hazards, reduces, fragments, or degrades coastal habitats that are essential for fish and wildlife, alters natural sediment flows, and contributes to coastal water pollution. While many of these impacts are attributable to activities taking place at the coast, others originate hundreds of miles away in inland watersheds.

Action: To effectively address these problems, the Commission recommends that coastal decision makers be given more capacity to plan for and guide growth away from sensitive and hazard prone areas. This can be facilitated by improving, coordinating, and consolidating the federal programs that have a role in managing coastal areas. In addition, coastal resources should be managed in the context of the watersheds that affect them; thus, greater links between coastal and watershed management will be needed.

Address the proliferation of activities in federal waters…
…to balance existing and new opportunities, safeguard marine and human health, minimize conflicts, and improve management of public resources for the benefit of the entire nation.

Challenge: Marine commerce, fishing, and offshore oil and gas development are all examples of well established activities that take place in federal waters, with equally well established institutional frameworks for managing them. However, these waters are becoming increasingly attractive for a host of new enterprises, ranging from offshore aquaculture to wind energy development, for which there are considerable management uncertainties. These uncertainties lead to confusion, conflict, lost opportunities, and environmental threats.

Action: The Commission calls for the creation of a coordinated offshore management regime that can encompass existing and emerging uses and address the impacts of multiple activities on a particular location, or on each other. This regime should be able to encourage opportunities, yet avoid and minimize conflicts among users, safeguard human and marine health, and fulfill the federal government's obligation to manage public resources for the maximum long-term benefit of the entire nation.

Reduce water pollution, particularly from nonpoint sources…
…to improve ocean and coastal water quality and ecosystem health.

Challenge: Ocean and coastal waters are subject to cumulative impacts from a variety of pollutants. Toxic chemicals, nutrients, excess sediment, airborne pollution, and waterborne diseases all threaten water quality.

Trash and litter, whether washed into the water from the shore or released at sea, is a significant problem. Aquatic invasive species, often introduced through the release of ships' ballast water, are a serious threat, often displacing or eliminating native species and altering the biology of ecosystems. Polluted runoff from urban, suburban, and agricultural activities is a particularly difficult problem that will require innovative and collaborative solutions, money, and time.

Action: Water contamination problems are diverse and pervasive and solutions will need to consider the links among oceans, coasts, and watersheds. The Commission recommends the establishment of measurable water pollution reduction goals, as well as coordination and cooperation of a broad range of agencies, programs, and individuals to achieve the right mix of management tools to address pollution of ocean and coastal waters.

Refine the existing fishery management system…
…to strengthen the use of science and move toward a more ecosystem-based management approach.

Challenge: The current fishery management regime has many positive features, including an emphasis on local participation, the pairing of science and management, and regional flexibility; nevertheless, the last 30 years have witnessed overexploitation of many fish stocks, degradation of habitats, and negative consequences for too many ecosystems and fishing communities. To make improvements and move toward an ecosystem-based management approach, stronger links between scientific information and management are needed, as are incorporation of more diverse viewpoints in the management process, and greater incentives to promote stewardship of marine resources.

Action: While fishery management should ultimately move toward a more ecosystem-based approach, near-term reforms can produce important improvements. Among them, the Commission recommends increasing the role of science by separating fishery assessment and allocation decisions, fine-tuning the Regional Fishery Management Council system, and exploring the use of dedicated access privileges.

Ratify the United Nations Convention on the Law of the Sea…
…to strengthen the nation's participation within the international community.

Challenge: In conjunction with improved ocean governance at home, the nation must also maintain its leadership role and participation within the international community. The best way to protect and advance our maritime interests is by continuing to actively engage in international policy-making, global scientific and observation initiatives, and programs to build ocean management capacity in developing countries.

Action: The Commission recommends that the United States accede to the United Nations Convention on the Law of the Sea, which is the primary legal framework for addressing international ocean issues. Critical national interests are at stake, and the United States can only be a full participant in upcoming Convention activities if we proceed with accession expeditiously.

Implementing a New National Ocean Policy

To date, there has been a significant under-investment in our marine assets. Implementation of the recommendations found throughout this report will contribute significantly to a future in which our oceans and coasts are rich with promise. Meaningful improvement will require meaningful investment, but the payoff will be sizable for the U.S. economy, human health, the environment, our quality of life, and security. The total preliminary estimated cost of the recommendations in this report is approximately \$1.3 billion in the first year of implementation, \$2.4 billion the second year, building to a sustained level of \$3.2 billion in ongoing costs thereafter. These figures will be refined as the Commission's recommendations are finalized.

This report includes a proposal for funding additional federal and state activities required to implement the Commission's recommendations. It is important to support new federal responsibilities and avoid creating unfunded mandates for states; consequently, the Commission recommends the establishment of an Ocean Policy Trust Fund in the Treasury. The Fund would be composed of outer Continental Shelf (OCS) oil and gas bonuses and royalties not otherwise allocated, and other revenues from new and emerging uses in offshore waters. Devoting a greater proportion of these revenue sources to benefit federal and coastal state efforts at managing our oceans and coasts will provide a stable revenue stream to implement the nation's new comprehensive national ocean policy.

At this moment we have an exciting opportunity to make positive and lasting changes in how we manage valuable ocean and coastal resources. We can create an improved national policy that better balances use with sustainability, is based on sound science and educational excellence, and moves toward an ecosystem-based management approach with a coordinated system of governance and active regional participation. These changes will require significant political will and investment and the support of an engaged and concerned public, but the benefits will far exceed the costs.

Critical Actions Recommended by the U.S. Commission on Ocean Policy

- **Establish a National Ocean Council, chaired by an Assistant to the President, and create a Presidential Council of Advisors on Ocean Policy in the Executive Office of the President.**
- **Strengthen NOAA and improve the federal agency structure.**
- **Develop a flexible and voluntary process for creating regional ocean councils, facilitated and supported by the National Ocean Council.**
- **Double the nation's investment in ocean research.**
- **Implement the national Integrated Ocean Observing System.**
- **Increase attention to ocean education through coordinated and effective formal and informal programs.**
- **Strengthen the link between coastal and watershed management.**
- **Create a coordinated management regime for federal waters.**
- **Create measurable water pollution reduction goals, particularly for nonpoint sources, and strengthen incentives, technical assistance, and other management tools to reach those goals.**
- **Reform fisheries management by separating assessment and allocation, improving the Regional Fishery Management Council system, and exploring the use of dedicated access privileges.**
- **Accede to the United Nations Convention on the Law of the Sea.**
- **Establish an Ocean Policy Trust Fund based on revenue from offshore oil and gas development and other new and emerging offshore uses to pay for implementing the recommendations.**

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PART I
OUR OCEANS: A NATIONAL ASSET

Chapter 1: Recognizing Ocean Assets and Challenges

America's oceans and coasts are priceless assets. Indispensable to life itself, they also contribute significantly to our prosperity and overall quality of life. Too often, however, we take these gifts for granted, underestimating their value and ignoring our impact on them. Then our use of the oceans becomes abuse, and the productive capacity of our marine resources is harmed.

That is why the nation needs, and should adopt, a comprehensive national ocean policy, implemented through an integrated and coordinated management structure that calls for greater participation and collaboration in decision-making. By rising to the challenge and addressing the many activities that are degrading the oceans and coasts, America can protect the ocean environment, while creating jobs, increasing federal revenues, enhancing security, expanding trade, and ensuring ample supplies of energy, minerals, healthy food, and life-saving drugs.

Evaluating the Vast Wealth of U.S. Oceans and Coasts

America is a nation surrounded by and reliant on the oceans. From the fisherman in Maine, to the homemaker in Oregon, to the businessperson in Miami, and even the farmer in Iowa, every American influences and is influenced by the sea. Our grocery stores are stocked with fish, our docks bustle with waterborne cargo, and millions of tourists visit our coastal communities each year, creating jobs and pumping dollars into our economy. Born of the ocean are clouds that bring life-sustaining rain to our fields and reservoirs, microscopic plankton that generate the oxygen we breathe, energy that fuels our industry and sustains our standard of living, and biological diversity that is unmatched on land. Careful stewardship of our ocean and coastal resources is imperative to conserve and enhance the financial, ecological, and aesthetic benefits we have come to rely upon and enjoy.

Economic and Employment Value

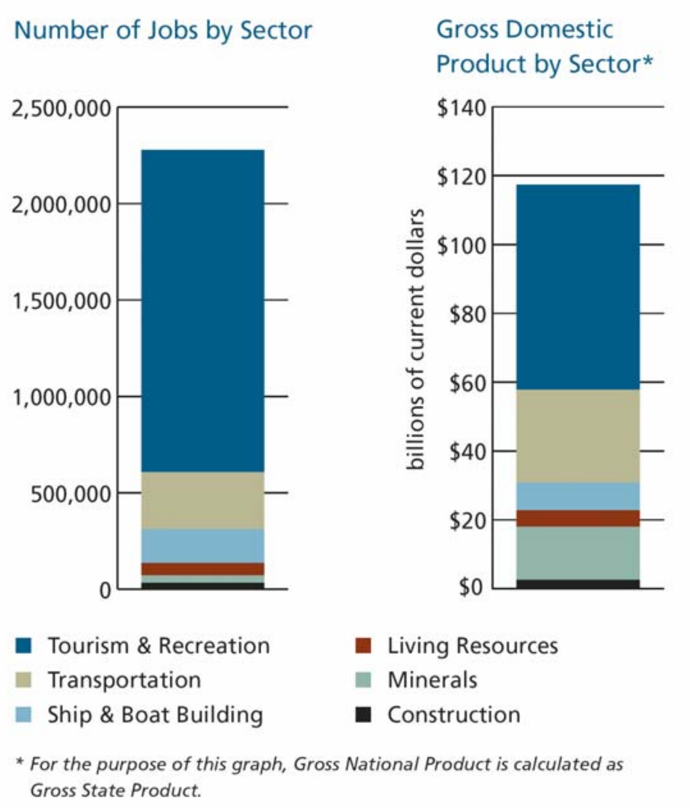
America's oceans and coasts are big business. The United States has jurisdiction over 3.4 million square nautical miles of ocean territory in its exclusive economic zone—larger than the combined land area of all fifty states. Millions of families depend on paychecks earned directly or indirectly from the resources of the sea. However, our understanding of the full economic value of these resources is far from complete. In contrast to sectors like agriculture on which the federal government spends more than $100 million a year for economic research, we do not make a serious effort to analyze and quantify the material contributions of our oceans and coasts. Standard government data are not designed to measure the complex ocean economy. They also ignore the intangible values associated with healthy ecosystems, such as clean water, safe seafood, healthy habitats, and desirable living and recreational environments. This lack of basic information has prevented Americans from fully understanding and appreciating the economic importance of our oceans and coasts.

To better inform the public and policy makers, the U.S. Commission on Ocean Policy partnered with the National Ocean Economics Project to produce an economic study, "Living Near…And Making A Living From...The Nation's Coasts And Oceans" (Appendix C). This study pulls together information from a wide range of sources and clearly shows that our oceans and coasts are among our nation's most vital economic assets.

In so doing, it distinguishes between the ***ocean economy,*** the portion of the economy that relies directly on ocean attributes, and the ***coastal economy,*** which includes all economic activity that takes place on or near the coast, whether or not that activity has a direct link to the sea.

In 2000, the ocean economy contributed more than $117 billion to American prosperity and supported well over two million jobs. Roughly three-quarters of the jobs and half the economic value were produced by ocean-related tourism and recreation (Figure 1.1). For comparison, ocean-related employment was almost 1½ times larger than U.S. agricultural employment in 2000, and total economic output was 2½ times larger than that of the farm sector.

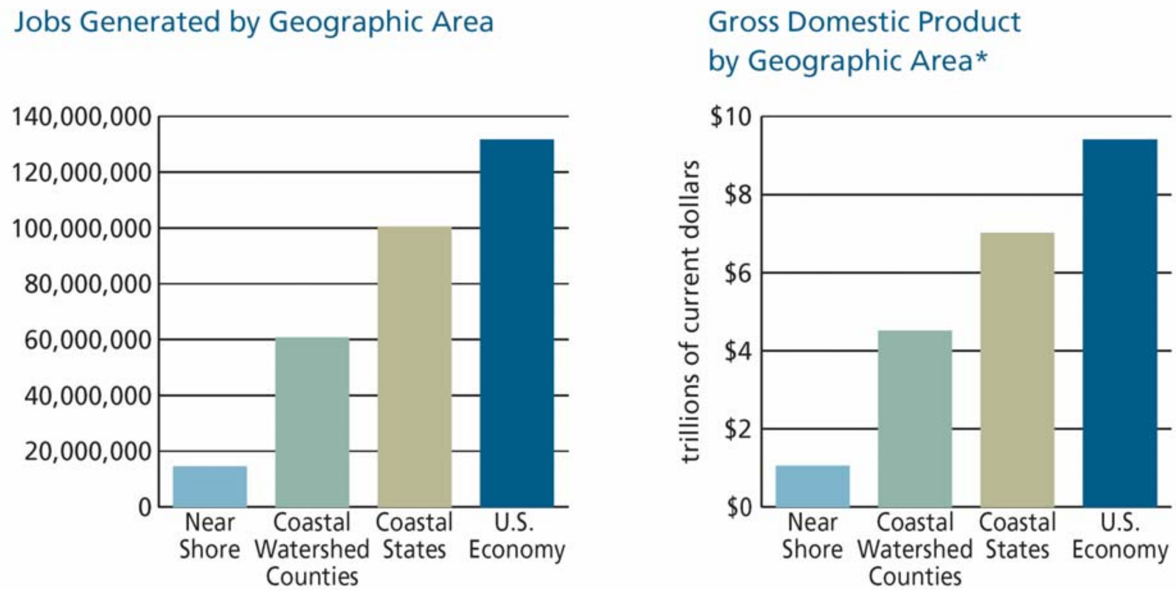
Figure 1.1. The Value of the Oceans



The ocean economy is the portion of the economy that relies directly on ocean attributes or that takes place on or under the ocean. The recreation and tourism sector is the largest in the ocean economy, providing approximately 1.6 million jobs.
Source: Living Near and Making a Living From the Oceans, Appendix C.

The level of overall economic activity within the coastal area is even higher (Figure 1.2). More than $1 trillion, or one-tenth, of the nation's annual gross domestic product (GDP) is generated within the *near shore* area, the relatively narrow strip of land immediately adjacent to the coast. Looking at all *coastal watershed counties*, the contribution swells to over $4.5 trillion, half of the nation's GDP. (For definitions of the different coastal zones, see the box on "Defining Coastal Areas.") The contribution to employment is equally impressive, with sixteen million jobs in the near shore zone and sixty million in coastal watershed counties. (See Appendix C for additional details.)

Figure 1.2. The Value of the Coasts



** For the purpose of the graph, GDP is calculated as Gross State Product.*

Coastal watershed counties, which account for less than a quarter of U.S. land area, are significant contributors to the U.S. economy. They are home to nearly half of the nation's jobs and generate a similar proportion of the nation's gross domestic product (GDP).

Source: Living Near and Making a Living From the Oceans, Appendix C.

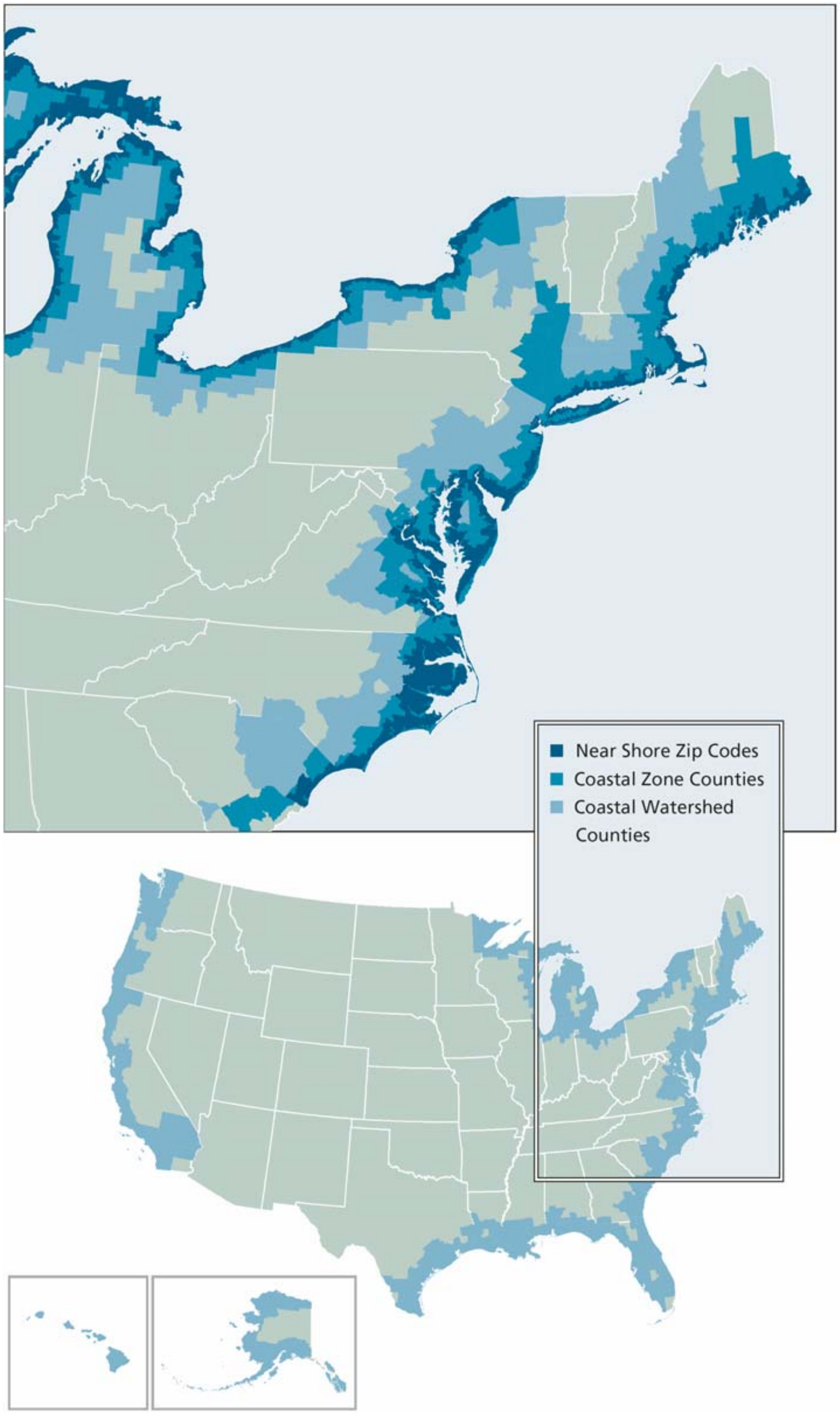
Even these remarkable numbers do not fully capture the economic contributions of coastal and ocean industries. More than thirteen million jobs are related to trade transported by the network of inland waterways and ports that support U.S. waterborne commerce.[1, 2] The oceans provide tremendous value to our national economy. Annually, the nation's ports handle more than $700 billion in goods,[3] and the cruise industry and its passengers account for $11 billion in spending.[4] The commercial fishing industry's total value exceeds $28 billion annually,[5] with the recreational saltwater fishing industry valued at around $20 billion,[6] and the annual U.S. retail trade in ornamental fish worth another $3 billion.[7] Nationwide retail expenditures on recreational boating exceeded $30 billion in 2002.[8] Governments at all levels, universities, and corporations provide many other jobs in oceans-related fields ranging from management and law enforcement to pollution prevention and research.

Our oceans and coasts are among the chief pillars of our nation's wealth and economic well-being. Yet our lack of full understanding of the complexity of marine ecosystems, and our failure to properly manage the human activities that affect them, are compromising the health of these systems and diminishing our ability to fully realize their potential.

Marine Transportation and Ports

The quality of life in America, among the best in the world, is made possible partly through access to goods and markets from around the globe. Our ports are endowed with modern maritime facilities and deep-water channels. Over the next two decades, overseas trade via U.S. ports, including the Great Lakes, is expected to double in volume; for some ports and types of trade, this increase will be even greater.[9] The expanding ferry and cruise line industries continue to provide economically valuable means of transportation for work and leisure. Marine transportation and ports also play a central role in national security as U.S. harbors and ports are major points of entry to our country.

Figure 1.3. The Coasts: From the Near Shore to Coastal Watersheds



Varying interpretations of the geographic area encompassed by the coast have hampered our ability to quantify the economic and ecologic importance of this dynamic region. Defining distinct regions, including the near shore, the coastal zone, and coastal watersheds, provides scientists and decision makers with clear boundaries as they develop policies and investigate coastal processes.

Source: Living Near and Making a Living From the Oceans, Appendix C.

Defining Coastal Areas

The coast is a widely used term encompassing numerous geographic subregions within the broad area where the land meets the sea. Areas of the coast identified in this and other chapters include coastal states, the coastal zone, coastal watershed counties, and the near shore (Figure 1.3). Some of these terms are defined in law, some agreed to by conventional usage, and others delineated specifically for use in this report.

Coastal States
This report uses the definition of a coastal state established by the Coastal Zone Management Act (CZMA). Under the CZMA, *coastal state* includes any state of the United States in, or bordering on, the Atlantic, Pacific, or Arctic Ocean, the Gulf of Mexico, Long Island Sound, or one or more of the Great Lakes, as well as Puerto Rico, the U.S. Virgin Islands, Guam, the Commonwealth of the Northern Mariana Islands and the Trust Territories of the Pacific Islands, and American Samoa. A total of thirty-five coastal states and territories fall under this definition.

Coastal Zone Counties
The term *coastal zone counties* refers to all counties that fall at least partly within a state's coastal zone, as defined under the CZMA. Under the CZMA, the coastal zone of most states with a federally approved coastal management program extends on its seaward side to 3 nautical miles offshore (the coastal zones of Texas and the west coast of Florida extend to 9 nautical miles, while those of Great Lakes states bordering Canada extend to the international boundary). The inland extent is determined by each participating state to include the upland region needed to manage activities with a direct and significant impact on coastal waters. Based on this definition, some states have designated their entire land area as the coastal zone, while others have specified certain political jurisdictions, distinct natural features, or geographic boundaries (Note: Although Illinois does not participate in the CZMA program, Cook and Lake Counties on Lake Michigan are considered coastal counties for the purposes of this report.)

Coastal Watershed Counties
Since approximately 1990, the National Oceanic and Atmospheric Administration has used a specific methodology,[10] also adopted by the U.S. Bureau of the Census after 1992, to define *coastal watershed counties*. The methodology combines the Census Bureau's delineation of counties and the U.S. Geological Survey's mapping of watersheds, identifying those counties with at least 15 percent of their land area in a coastal watershed. Based on this methodology, the United States has 673 coastal watershed counties: 285 along the Atlantic Ocean; 142 in the Gulf of Mexico region; 87 bordering the Pacific Ocean; and 159 fronting the Great Lakes.[11]

The Near Shore
To allow for more detailed analyses of economic conditions in the region closest to the coastline, this report defines the *near shore* as postal zip code areas that touch the shoreline of the oceans, Great Lakes, and major bays and estuaries.

Marine Fisheries

Sustainable sources of fish and shellfish are critical to the United States as a source of healthy food, financial revenue, and jobs. Americans consume more than 4 billion pounds of seafood at home or in restaurants and cafeterias every year. This represents about $54 billion in consumer expenditures.[12] As the population grows and problems such as heart disease and obesity continue to plague our nation, the desire and need for a relatively low-fat source of protein will rise. If every person in America followed the American Heart Association's recommendation to eat at least two servings of fish per week, the United States would need an additional 1½ billion pounds of seafood each year.

Worldwide, fish are even more important as a source of protein. More than 3 billion people derive at least one-fifth of their needed protein from freshwater and saltwater fish, and in some parts of the world fish provide the sole source of animal protein. The aquaculture industry, which has become the fastest growing sector of the world food economy, now supplies more than 25 percent of the globe's seafood consumption.[13,14]

In addition to their dietary value, fish are fundamental to the economy, culture, and heritage of many coastal communities in the United States. Fishing has deep cultural, even spiritual roots in many seafaring cities and villages where it has provided both a vocation and recreation for hundreds of years.

Offshore Energy, Minerals, and Emerging Uses

Valuable oil and mineral resources are found off our shores and in the seabed; they fuel our cars and our economy, provide materials for construction and shoreline protection, and offer exciting opportunities for the future. Currently, about 30 percent of the nation's oil supplies and 25 percent of its natural gas supplies are produced from offshore areas.[15] These energy supplies also provide a major source of revenue and tens of thousands of jobs. Since the start of the offshore oil and gas program, the Department of the Interior has distributed an estimated $145 billion to various conservation funds and the U.S. Treasury from bonus bid and royalty payments related to ocean energy.[16]

While advances in technology are enabling the offshore industry to drill deeper, cleaner, and more efficiently, increasing energy demands coupled with environmental concerns have spurred efforts to find alternative sources of power. Modern technology is creating the opportunity to use wind, waves, currents, and ocean temperature gradients to produce renewable, clean energy in favorable settings. Extensive gas hydrates in the seabed also hold promise as a potential—though not yet economically and environmentally feasible—source of energy.

In addition to energy, our offshore waters and the underlying seabed are also rich sources of non-petroleum minerals and sand. As easily accessible sand resources are depleted, offshore areas along the mid-Atlantic and Gulf coasts will be used increasingly to provide sand to restore and protect coastal communities, beaches, and habitat. Minerals, such as phosphates, polymetalic sulfides, and deposits that form around high-temperature vents, may also have commercial value some day if technical and economic barriers to their extraction can be overcome.

Interest in the ocean goes beyond the traditional resource industries. The telecommunications industry's investment in submerged cables will continue as international communication needs expand. There is also growing interest in other offshore uses including aquaculture, carbon dioxide sequestration, artificial reefs, conservation areas, research and observation facilities, and natural gas offloading stations.

Human Health and Biodiversity

The ocean provides the largest living space on earth and is home to millions of species, with perhaps as many more yet to be discovered. Within this vast biological storehouse, there exists a treasure trove of potentially useful organisms and chemicals that provide the foundation for a budding multibillion-dollar marine biotechnology industry.

Over the past two decades, thousands of marine biochemicals have been identified. Many have potential commercial uses, especially in the fields of health care and nutrition. For example, a chemical originally derived from a sea sponge is now the basis of an antiviral medicine and two anticancer drugs. Blood drawn from the horseshoe crab is used to detect potentially harmful toxins in drugs, medical devices, and water. A synthetic drug that copies the molecular structure of a salmon gland extract is one of the new treatments available to fight osteoporosis. And coral, mollusk, and echinoderm skeletons are being tested as orthopedic and cosmetic surgical implants.

Scientists are also growing marine organisms in the laboratory and using them as models for physiological research. For example, they are using the damselfish to study cancer tumors, the sea hare and squid to investigate the nervous system, and the toadfish to investigate the effects of liver failure on the brain. In addition, bacteria and other organisms living in extreme deep-sea environments hold promise for the bioremediation of oil spills and other wastes.

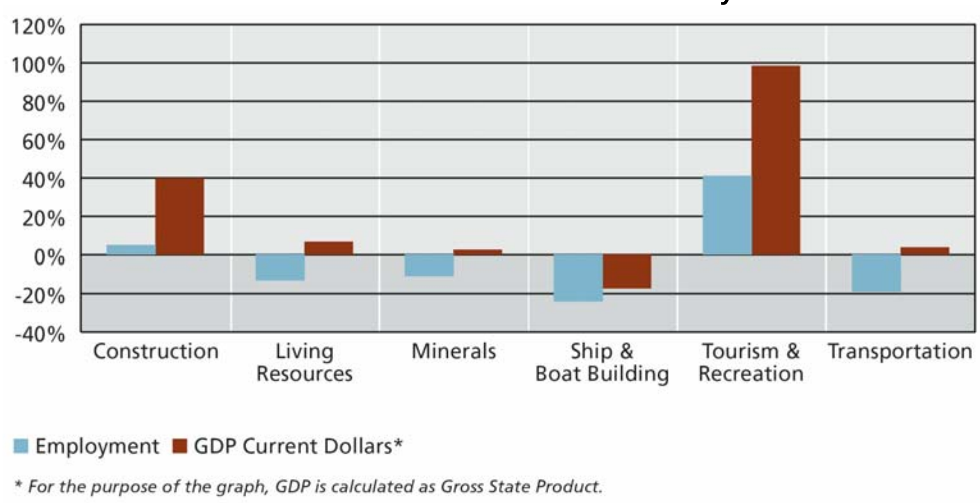
Remarkably, in this first decade of the 21st century about 95 percent of the world's ocean area remains unexplored. We have barely begun to comprehend the full richness and value of the diverse resources residing beneath the surface of the sea.

Tourism and Recreation

Every year, hundreds of millions of American and international visitors flock to the nation's coasts to enjoy the many pleasures the ocean affords, while spending billions of dollars and directly supporting more than a million and a half jobs. Millions of other tourists take to the sea aboard cruise ships, and still more visit the nation's aquariums, nautical museums, and seaside communities to learn about the oceans and their history. Tourism and recreation constitute by far the fastest growing sector of the ocean economy (Figure 1.4), extending virtually everywhere along the coasts of the continental United States, southeast Alaska, Hawaii, and our island territories and commonwealths. This rapid growth will surely continue as incomes rise, more Americans retire, and leisure time expands.

The value of ocean recreation, however, extends beyond the number of jobs and income produced, for there are benefits to society in the relaxation and exercise derived from a day at the beach or on the water. While there is no universally agreed upon method to calculate the economic value of such intangible benefits, several studies have attempted to do so. In southern California, just one beach, Santa Monica, generates more than an estimated \$200 million in user values.[17] Two Ohio beaches generate annual values of \$9.6 million. [18] Coral reefs are also a major source of recreational values, with those in Hawaii generating an estimated \$360 million.[19]

Figure 1.4. The Shift from Goods to Services in the Ocean Economy



Between 1990 and 2000, the ocean economy followed national trends with a significant increase in the importance of service oriented activities. This trend is clearly illustrated by the dramatic increase in both employment and industry output associated with the tourism and recreation sectors of the ocean economy. Shifts in employment and revenue in the traditional goods producing sectors— minerals, living resources, transportation, ship and boat building— were impacted by changes in technology, national priorities, and the status of living and nonliving resources.
Source: Living Near and Making a Living From the Oceans, Appendix C.

Coastal Real Estate

It is no secret that people are attracted to our coasts. They want to buy property and raise their families near the ocean, and visit it during vacations and on the weekends. They want to fish, sail, swim, and listen to the waves crashing, and gaze upon the watery horizon at sunset. This has made areas close to the seashore some of the most sought-after property in our nation. Coastal watershed counties comprise less than 25 percent of America's land area, yet they are home to more than 50 percent of our population (Appendix C). Nine of our country's ten largest cities are located in coastal watershed counties.[20] Waterfront properties often sell or rent for several times the value of similar properties just a short distance inland. Even a decade ago, eighteen of the twenty wealthiest U.S. counties (ranked by per capita income) were coastal counties.[21] [22]

Nonmarket Values

Many of the most valuable assets of our oceans and coasts are not readily measurable by market-based accounting. Most dramatically, of course, we need the oceans to live and breathe. Other ocean assets, such as functioning coastal habitats, contribute to the health of our environment and the sustainability of commercial and recreational resources. Still others assist in what our nation's founders referred to as the "pursuit of happiness." It may not be possible to assign a dollar value to all the functions of the sea, but it is necessary to bear each in mind when determining the rightful priority of marine management and protection on the policy agenda of our nation.

Life Support and Climate Control

The oceans provided the cradle from which all life evolved. They sustain life through evaporation which fills the atmosphere with vapor, producing clouds and rain to grow crops, fill reservoirs, and recharge underground aquifers.

The oceans can absorb over a thousand times more heat than the atmosphere, storing and transporting it around the globe. They also hold sixty-five times more carbon than the atmosphere and twenty times more than terrestrial biomass,[23] a critical factor in counteracting the excess carbon dioxide emitted by human activities. Ocean carbon is used by the sea's immense population of phytoplankton to produce oxygen for our atmosphere. The oceans' dominant role in the cycling of water, heat, and carbon on the planet has profound, and poorly understood, impacts on global climate change.

Marine Habitat

Wetlands, estuaries, barrier islands, seagrass and kelp beds, coral reefs, and other coastal habitats are vital to the health of marine and estuarine ecosystems. They protect the shoreline, maintain and improve water quality, and supply habitat and food for migratory and resident animals. An estimated 95 percent of commercial fish and 85 percent of sport fish spend a portion of their lives in coastal wetlands.[24]

Coral reefs cover only about one-fifth of 1 percent of ocean area and yet provide home to one-third of all marine fish species and tens of thousands of other species. Coral reef fisheries yield 6 million metric tons of seafood annually, including one-quarter of fish production in developing countries.[25] In addition to their immense ecological and direct economic benefits, healthy marine habitats offer highly valuable recreation and tourism opportunities and enhance the worth of coastal real estate.

Exploration, Inspiration, and Education

Throughout history, the ocean's mysteries and our reliance on its resources have inspired great works of literature and art, spurred the human instinct to explore, and provided diverse forms of entertainment. Shipwrecks, prehistoric settlements, and other submerged sites document and preserve important historical and cultural events, while offering unique opportunities for both professional archeologists and recreational divers and for educating the public.

With only about 5 percent of the ocean having been explored, the sea also offers something rare on Earth today: the unknown. Only thirty years ago, no one contemplated the existence of vast biological communities living in the deep sea at hydrothermal vents or the associated mineral-rich flows that form towers more than 50 feet high. Today, we are just beginning to learn about the immense scope of microbial life within and below the seabed.

The ocean provides an exciting way to engage people of all ages in learning and inspire academic achievement in the nation's schools. Using the oceans as a unifying theme, students can participate in research at sea, and teachers can connect mathematic and scientific principles with real-world problems, environmental issues, and the use of modern technology. From young to old, in formal and informal education, the ocean offers an unparalleled tool to improve the literacy and knowledge of our citizens. If we are sufficiently creative, we can produce an entire new generation of experts and cultivate a fresh appreciation and understanding that will deepen the stewardship ethic within our society.

International Leadership

Most nations border or have access to the sea, and all are affected by it. People everywhere have a stake in how well the oceans are managed, how wisely they are used, and how extensively they are explored and understood. For the United States, this means the oceans provide an ideal vehicle for global leadership. From international security, to ocean resource management, education, scientific research, and the development of ocean-related technology, the United States can gain respect by demonstrating exemplary policies and achievements at home and seeking to spread positive results through collaborative efforts around the world.

The "Fourth Seacoast"

As explained by Michael J. Donohue in testimony before the Commission (Appendix 2), the Great Lakes system enjoys global prominence, containing some 6.5 quadrillion gallons of fresh surface water, a full 20 percent of the world's supply and 95 percent of the United States' supply. Its component parts—the five Great Lakes—are all among the fifteen largest freshwater lakes in the world. Collectively, the lakes and their connecting channels comprise the world's largest body of fresh surface water. They lend not only geographic definition to the region, but help define the region's distinctive socioeconomic, cultural and quality of life attributes, as well.

An international resource shared by the United States and Canada, the system encompasses some 95,000 square miles of surface water and a drainage area of almost 200,000 square miles. Extending some 2,400 miles from its western-most shores to the Atlantic, the system is comparable in length to a trans-Atlantic crossing from the East Coast of the United States to Europe. Recognized in U.S. federal law as the nation's "fourth seacoast," the Great Lakes system includes well over 10,000 miles of coastline. The coastal reaches of all basin jurisdictions are population centers and the locus of intensive and diverse water-dependent economic activity. Almost 20 percent of the U.S. population and 40 percent of the Canadian population resides within the basin.

UNDERMINING AMERICA'S OCEAN AND COASTAL ASSETS

Human ingenuity and ever-improving technology have enabled us to harvest—and significantly alter—the ocean's bounty. Our engineering skills have allowed us to redirect the course of rivers, deflect the impacts of waves, scoop up huge quantities of fish, and transform empty shorelines into crowded resort communities. Yet the cumulative effects of these actions threaten the long-term sustainability of our ocean and coastal resources. Through inattention, lack of information, and irresponsibility, we have depleted fisheries, despoiled recreational areas, degraded water quality, drained wetlands, endangered our own health, and deprived many of our citizens of jobs. If we are to adopt and implement an effective national ocean policy, we must first understand and acknowledge the full consequences of failing to take action.

Degraded Waters

Despite some progress, America's ocean and coastal ecosystems continue to show signs of degradation, thereby compromising human health, damaging the economy, and harming marine life. In 2001, 23 percent of the nation's estuarine areas were impaired for swimming, fishing, and supporting marine species.[26] Meanwhile, pollution could jeopardize the safety of drinking water for millions of people living near or around the Great Lakes.

Excess Nutrients

The oversupply of nitrogen, phosphorus, and other nutrients in coastal ecosystems is one of our nation's most widespread pollution problems. Runoff from agricultural land, animal feeding operations, and urban areas, along with discharges from wastewater treatment plants, storm sewers, and leaky septic systems, adds nutrients to waters that eventually enter the sea.

All told, more than eighty of our bays and estuaries show signs of nutrient overenrichment, including oxygen depletion, loss of seagrass beds, and toxic algal blooms.[27] And not all of these excess nutrients come from local sources. The Gulf of Mexico's "dead zone" is the result of cumulative drainage from the Mississippi–Atchafalaya River Basin, which includes all or parts of thirty states.[28] In addition, atmospheric deposition from agriculture, power plants, industrial facilities, motor vehicles, and other often distant sources accounts for up to 40 percent of the nitrogen entering estuaries.[29, 30]

Other Contaminants

A 2003 National Research Council report found that every year, more than 28 million gallons of oil from human activities enter North American waters. Land-based runoff accounts for well over half of this. Much smaller amounts of oil enter our waterways from tanker and barge spills and from recreational boats and personal watercraft.[31]

Pollution from sewage treatment plants has been reduced as the result of tighter regulation during the past thirty years, but concerns remain about the release of untreated human pathogens, pharmaceuticals, toxic substances, and chlorinated hydrocarbons. In 2002, more than 12,000 beach closings and swimming advisories were issued across the nation, most due to the presence of bacteria associated with fecal contamination. The number of such actions continues to rise,[32] costing many millions of dollars a year in decreased revenues for tourism and recreation and higher costs for health care.

Harmful Algal Blooms

For reasons not yet clearly understood, harmful algal blooms are occurring more frequently both within America's waters and worldwide. The consequences are particularly destructive when the algae contain toxins.

Marine toxins afflict more than 90,000 people annually across the globe and are responsible for an estimated 62 percent of all seafood-related illnesses. In the United States, contaminated fish, shellfish, and other marine organisms are responsible for at least one in six food poisoning outbreaks with a known cause, and for 15 percent of the deaths associated with these incidents.[33] In the last two decades, reports of gastrointestinal and neurological diseases associated with algal blooms and waterborne bacteria and viruses have increased.[34] Though seafood poisonings are probably underreported, they also seem to be rising in incidence and geographic scope.[35]

Harmful algal blooms cost our nation an average of $49 million a year[36] due to fisheries closures, loss of tourism and recreation, and increased health care and monitoring expenses.

Sediment Contamination

A study conducted at more than 2,000 sites representing over 70 percent of the nation's total estuarine area (excluding Alaska) found that 99 percent of the sediments tested contained five or more toxic contaminants at detectable levels. More than 600 sites had contamination levels high enough to harm fish and other aquatic organisms.[37] Because some chemicals tend to bind to particles and thus accumulate in sediments, bottom-dwelling and bottom-feeding organisms are especially at risk. As sediment-bound pollutants enter these organisms and move up through the food web, larger animals and humans are also affected. Excess sediments can also cause harm by smothering stationary bottom-dwelling marine communities.

Compromised Resources

Fishery declines, degraded coastal habitats, and invasive species are compromising our ability to meet current and future demands for healthy, productive marine resources.

Fishery Declines

Experts estimate that 25 to 30 percent of the world's major fish stocks are overexploited,[38] and a recent report indicates that U.S. fisheries are experiencing similar difficulties. Of our nation's 259 major fish stocks—representing 99 percent of total commercial landings—roughly 25 percent are either already overfished or experiencing overfishing.[39] The same report indicates that the status of 650 other fish stocks—most of which are not subject to commercial fishing pressure—is unknown, limiting both our understanding of the overall state of the nation's fisheries and of their role in the marine ecosystem.

Declining fish populations are the result of overfishing, the unintentional removal of non-targeted species (known as bycatch), habitat loss, pollution, climate change, and uneven management. The cumulative impacts of these factors is serious. As fishing boats turn to smaller, less valuable, and once discarded species, they are progressively "fishing down the food web," thereby causing changes in the size, age structure, genetic makeup, and reproductive status of fish populations. This seriously compromises the integrity of marine ecosystems, the ecological services they provide, and the resources upon which Americans rely.

Although U.S. fishery management has been successful in some regions, failures elsewhere have resulted in substantial social and economic costs. For example, the collapse of the North Atlantic cod fishery in the early 1990s resulted in the loss of an estimated 20,000 jobs and $349 million.[40, 41] In the Northwest, decreasing salmon populations have cost 72,000 jobs and more than $500 million.[42] This tally does not begin to assess the social and psychological impacts these events have had on individuals, families, and communities for whom fishing has been a tradition for generations.

Questions also exist about how best to manage our growing marine aquaculture industry. This industry is vital to increase seafood supplies, but its potential impact on the ocean environment and wild populations of fish and shellfish present serious concerns. These include the discharge of wastes and chemicals, the spread of disease or genetic changes resulting from the escape of farmed species, the demand for wild-caught fish as aquaculture feed, and the appropriation of sensitive habitats to create aquaculture facilities.

Coastal Habitat Loss

Since the Pilgrims first arrived at Plymouth Rock, the lands that now comprise the United States have lost over half of their fresh and saltwater wetlands—more than 110 million acres.[43] California has lost 91 percent of its wetlands since the 1780s.[44] And Louisiana, which currently is home to 40 percent of the coastal wetlands in the lower forty-eight states, is losing 25–35 square miles of wetlands each year.[45]

Pollution, subsidence, sea level rise, development, and the building of structures that alter sediment flow all contribute to the problem. With the loss of the nation's wetlands, shorelines are becoming more vulnerable to erosion, saltwater is intruding into freshwater environments, flooding is on the rise, water quality is being degraded, and wildlife habitat is being fragmented or lost.

The nation is also losing thousands of acres of seagrass and miles of mangrove and kelp forests. More than 50 percent of the historical seagrass cover has been lost in Tampa Bay, 76 percent in the Mississippi Sound, and 90 percent in Galveston Bay.[46] Extensive seagrass losses have also occurred in Puget Sound, San Francisco Bay, and along Florida's coasts.

Coral reef habitats are also increasingly under siege. Recent research suggests that direct human disturbances and environmental change are two major causes of harm to coral reefs, although a host of other factors also contribute. Many reefs, particularly those within range of growing human populations, are under threat of destruction as evidenced by dramatic declines in Florida, the Caribbean, and parts of Hawaii.[47, 48] Coral reef declines are exacerbated by cumulative impacts, such as when overfishing, coral bleaching, and disease decrease a reef's resilience. As the reefs disappear, so do the fish they harbor and the millions of dollars in jobs and economic revenue they provide.

Invasive Species

Across the nation and throughout the world, invasive species of plants and animals are being intentionally and unintentionally introduced into new ecosystems, often resulting in significant ecological and economic impacts. We know that over 500 non-native species have become established in coastal marine habitats of North America and that hundreds can be found in a single estuary.[49] Asian and European shore crabs inhabit the coasts of New England and California, damaging valuable fisheries. A massive horde of zebra mussels has assaulted the Great Lakes, clogging power plant intakes and fouling hulls, pilings, and navigational buoys. And in the Chesapeake Bay, an alien pathogen has contributed to the decline of the native oyster population.[50]

Most non-native marine animals and plants are introduced through the discharge of ships' ballast water and holding tanks. At least 7,000 different species of marine life are transported around the world every day, and every hour some 2 million gallons of ballast water arrive in U.S. waters carrying at least a portion of this immense fleet of foreign organisms.[51, 52] Further contributors to the spread of invasive species include the aquarium trade, fisheries-related activities, floating marine debris, boating, navigational buoys, and drilling platforms. Strains on coastal environments caused by other factors may make them even more vulnerable to the spread of non-native species.

The economic impact of invasive species can be substantial. From 1989 to 2000, zebra mussels alone caused between $750 million and $1 billion in losses to natural resources and damage to infrastructure in the Great Lakes. California has spent more than $2 million to control and monitor the spread of the Mediterranean green seaweed *Caulerpa taxifolia* and more than $3 million investigating the impacts of Atlantic cordgrass on the Pacific Coast. Invasive species can also cause significant ecological damage by outcompeting native species, altering local food webs, and reducing the resources available for other organisms.[53]

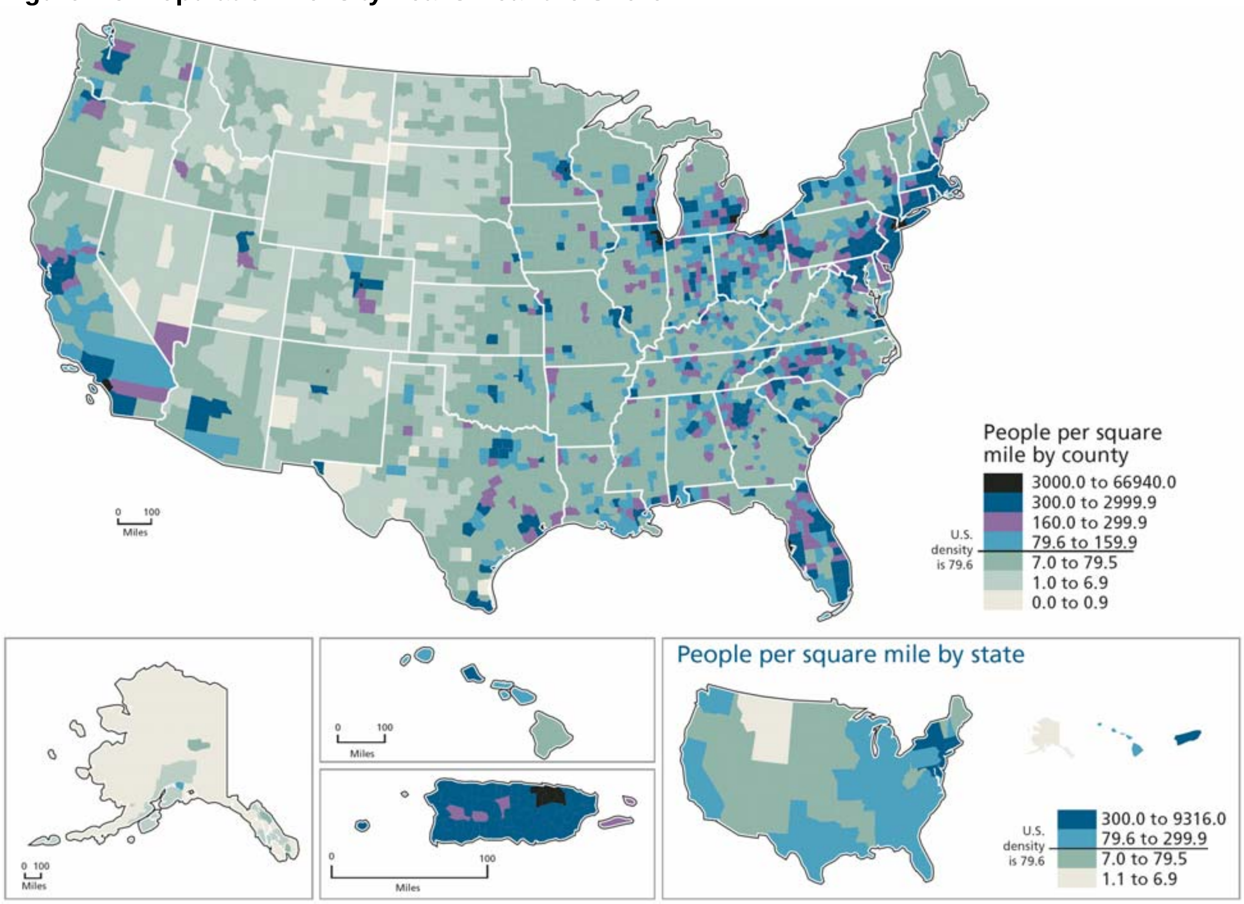
Conflicts Between Man and Nature

As population density has risen in coastal watersheds, so has environmental stress. Coastal planning and management polices implemented over the past thirty years have limited, but not prevented, harmful impacts—both incremental and cumulative—on the marine ecosystem.

Coastal Population Growth and Land Use

Contrary to popular perception, the coasts have experienced a relatively stable rate of population growth since 1970; coastal watershed counties representing 25 percent of the nation's land area have continued to support approximately 52 percent of the U.S. population over the past three decades (Appendix C). Between 1970 and 2000, the population of coastal watershed counties grew by 37 million people (Appendix C) and is projected to increase by another 21 million by 2015. [54] At that point, the U.S. coasts will have absorbed more than 58 million additional residents since 1970—more than 1.1 million a year. This steady influx of people into a relatively small area has already created coastal population densities that are on average two to three times higher than that of the nation as a whole (Figure 1.5).

Figure 1.5. Population Density Peaks Near the Shore



As shown by the 2000 U.S. Census, population density is generally highest in coastal counties, including counties surrounding the Great Lakes. General population growth and increasing population density in coastal counties reflects the attraction of the coast but also results in increased environmental impacts on coastal ecosystems.
Source: U.S. Census Bureau, Census 2000 <www.census.gov> (Accessed March, 2004).

The environmental impacts of rising population density in the coastal zone have been magnified by a relative shift in population and housing development away from expensive shoreline property and toward the upland reaches of coastal watersheds. This has had the effect of expanding environmental consequences over larger geographic areas and has eroded the health of ecosystems and resources throughout coastal watersheds.

Most development profoundly changes the landscape. Impervious materials such as concrete or asphalt typically cover 25–60 percent of the land surface in medium-density, single-family-home residential areas, and more than 90 percent in strip malls, urban areas, and other commercial sites.[55] Research indicates that nearby water bodies can become seriously degraded when more than 10 percent of a watershed is covered by roads, parking lots, rooftops, and similar surfaces.[56] A one-acre parking lot produces sixteen times the volume of runoff that comes from a one-acre meadow.[57] Expanding coastal sprawl can also destroy natural habitats, thus compromising the environment's ability to provide food and refuge for wildlife or supply ecosystem services, such as maintaining water quality.

These concerns are exacerbated by the fact that land is being developed for housing at more than twice the rate of population growth.[58] This is partly the result of a decline in the size of the average American household from 3.14 people in 1970 to 2.59 people in 2000.[59] Near shore areas also experience spurts of temporary population growth—from commuters, vacationers, day-tourists and others—creating a robust demand for seasonal housing. The result is pressure for development in near shore areas accelerating at a rate far greater than might be expected based simply on population trends.

A less apparent, but still important contributor to developmental pressures is the increasing rate of overall economic growth that is occurring in near shore areas. Although population and housing are moving upstream within coastal watersheds, economic growth has been occurring more rapidly—and more intensely—along the near shore. This growth has tended to focus on the trade and service industries, which use more land per unit of output than other types of activity. Thus, it is important to understand the significance of the growing recreation and tourism industry and the relative impact its related businesses are having on the coast, in addition to managing coastal population growth.

Natural Hazards

As the nation's shores become more densely populated, people and property are increasingly vulnerable to costly natural hazards. Before 1989, no single coastal storm had caused insured losses greater than $1 billion.[60] Since then, at least ten storms have resulted in such losses, including Hurricane Andrew, with insured losses of $15.5 billion and total economic losses estimated at $30 billion (in 1992 dollars).[61, 62]

Coastal erosion, storm surges, tsunamis, and sea level rise are serious threats to people living and working along the shore, particularly in low-lying areas. Roughly 1,500 homes and the land on which they are built are lost to erosion each year, with annual costs to coastal property owners expected to average $530 million over the next several decades.[63] In some instances, American engineering capability has improved protection against natural hazards along the coast; in others, however, it has made us more vulnerable. The loss of wetlands and other shoreline vegetation increases susceptibility to erosion and flooding. The installation of seawalls, groins, and other coastal armoring structures can alter patterns of sediment and current flow, eventually accelerating erosion, rather than preventing it.

Climate Change

Average global temperatures have been rising over the last several decades. Scientists believe these changes are probably due primarily to the accumulation of greenhouse gases in Earth's atmosphere from human activities, although natural variability may also be a contributing factor.[64] The Intergovernmental Panel on Climate Change reports that the average near-surface temperature of the Earth increased by about 1˚F between 1861 and 1990, but is expected to increase by another 2.5 – 10.4˚F by the end of this century.[65] As oceans warm, the global spread and incidence of human diseases, such as cholera and malaria, may also increase.[66, 67] Marine organisms that are sensitive to temperature must either alter their geographic distribution or face extinction. Already, changing ocean conditions in the North Pacific have altered ecosystem productivity and have been associated with poor ocean survival of young salmon and modifications in the composition of near shore fish populations.[68]

One of the most immediate phenomena associated with increasing global temperatures has been a change in average sea level, which is estimated to have risen by 4–8 inches during the 20th century. By 2100, sea level is projected to rise by another 4–35 inches.[69] Although the exact amount and rate of the increase are uncertain, the fact that the ocean will continue to expand is not. As this occurs, low-lying coastal regions and island territories will be particularly vulnerable to flooding and storms. In the Pacific, for example, entire archipelagos have maximum elevations of only a few meters above sea level, leaving both human communities and natural ecosystems in danger. This vulnerability is compounded by the concentration of human activities along the water's edge, the point of greatest risk. Many island jurisdictions are already facing problems associated with long-term sea level rise, including saltwater contamination of fresh water sources, coastal erosion, damage to natural barriers such as coral and mangroves, and loss of agricultural sites and infrastructure. Saltwater intrusion has rendered aquifers on the Marshall Islands unusable, and ocean waters regularly flood the airport. A steady increase in sea level rise could cause whole islands to disappear.

Polar regions are exhibiting dramatic signs of change due to rising temperatures, with thinning ice caps and melting glaciers. The average thickness of sea ice in the Arctic has decreased by almost 10 feet over the last thirty to forty years.[70] Dramatic changes are also occurring in Arctic permafrost, with potentially significant economic and ecological impacts.[71] In the tropics, coral reef diseases and bleaching are occurring more frequently, and coral growth may be inhibited by increasing concentrations of dissolved carbon dioxide in the sea.[72]

The transport and transformation of heat, carbon, and many other gases and chemicals in the ocean play a central role in controlling, moderating, and altering global climate. In fact, research into ancient climate cycles suggests that change can actually occur much more rapidly than once expected.[73] Rather than the scenario of gradual surface temperature increases often envisioned for the next century, sudden shifts in polar ice and ocean circulation could result in drastic temperature changes occurring within a decade or less.[74]

The specter of abrupt change, and a growing awareness of the impacts climate change could have on coastal development, terrestrial and marine populations, and human health, calls for a significant improvement in climate research, monitoring, assessment, and prediction capabilities.

Acting Today for Tomorrow's Generations

For centuries, Americans have been drawn to the sea. We have battled the tides, enjoyed the beaches, and harvested the bounty of our coasts. The oceans are among nature's greatest gifts to us. The responsibility of our generation is to reclaim and renew that gift for ourselves, for our children, and—if we do the job right—for those whose footprints will mark the sands of beaches from Maine to Hawaii long after ours have washed away.

The nation's ocean and coastal assets are worth hundreds of billions of dollars to society and untold more to the Earth and its complex ecosystems. Although losses in some areas have been significant and continue, in other areas sound policy and sustained investments have slowed or reversed harmful trends. There is every reason to believe that wise actions taken today, based on the best available science, can restore what has been lost and create benefits even greater than we see today. But to obtain these benefits, our nation's leaders must take immediate steps to formulate a coherent, comprehensive, and effective national ocean policy. Implementation of the far-reaching recommendations offered throughout this report can halt the losses and help restore, protect, and enhance America's ocean assets.

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Chapter 2: Understanding the Past to Shape a New National Ocean Policy

The phrase national ocean policy *encompasses a vast array of issues, each of which requires policy makers to answer some key questions: what goals do we want to achieve, what rules, if any, are to apply, and who is to formulate and enforce those rules? They must also be prepared to justify their decisions to a wide variety of interested people and find a way to place decisions about particular uses of the oceans into a larger framework so the results will be coherent and enduring. In considering how to craft such a framework for the future, the U.S. Commission on Ocean Policy reviewed the lessons of the past and listened closely to affected individuals around the country.*

Ocean Policy from World War II to the Oceans Act of 2000

Volumes have been written about the intricacies of ocean policy and its development in the United States. The following sections offer a brief glimpse of this history, setting the stage for the work of the U.S. Commission on Ocean Policy.

Formative Years

U.S. ocean policy developed slowly and fairly consistently from the founding of the United States until the immediate aftermath of World War II. Since then, it has zigged and zagged in response to shifting public attitudes based on major events related to national security, the environment, and political philosophy. American policy—or more accurately the amalgamation of many policies—has been shaped by the nation's unique status as both the world's leading maritime power and the possessor of a long and rich shoreline, giving us a stake both in protecting freedom of navigation and in expanding the resource jurisdiction of coastal countries. Over time, our management of ocean issues has been roiled by conflicting interests of the federal and state governments, torn by tensions between short- and long-term needs, blurred by ideological disagreements, and complicated by the wide variety of uses we make of our vast and versatile—but also vulnerable—seas.

One ongoing challenge for policy makers has been to find the right balance between the exploitation of marine resources, whether living or nonliving, and the conservation of those resources and protection of the marine environment. Petroleum exploration, commercial fishing, and marine mammal protection are just three of the arenas where this drama has played out. The United States has also shown a tendency to swing back and forth between internationalism and unilateralism—at times working with other countries to shape global rules, and at other times asserting the right to establish our own rules outside of, or in advance of, the global consensus.

The nation's primary maritime concerns have been to preserve the right to free navigation while asserting jurisdiction over fishing and law enforcement in U.S. waters. In a letter from Secretary of State Thomas Jefferson to the governments of Britain and France in 1793, the United States officially claimed authority over a 3 nautical mile territorial sea. Over the next century and a half, the federal government's role in the oceans was limited primarily to the activities of the U.S. Navy, the U.S. Coast Guard, and the Coast and Geodetic Survey; the promotion of the U.S. Merchant Marine; and diplomatic negotiations over access to the rich fishing grounds off the North Atlantic coast and the taking of fur seals in the North Pacific and Bering Sea.

Interestingly, the problem of depleted fish stocks, often assumed to be a recent development, is not new. In 1871, the federal government established the Office of the Commissioner of Fish and Fisheries to study the dilemma. Warnings have been issued and various remedies proposed periodically ever since. In 1882, the first U.S. research vessel built exclusively for fisheries and oceanographic research entered service, and for the next thirty-nine years the 234-foot USS *Albatross* plied waters around the globe.

It was not until after World War II that a process referred to as *enclosure of the oceans* began in earnest. In contrast to the traditional view of the oceans as belonging to everyone (and therefore to no one), a movement to extend the rights of coastal states gathered momentum. Among the factors driving this trend was competition for oil and gas. On September 28, 1945, President Truman issued a proclamation asserting control over the natural resources of the continental shelf beneath the high seas adjacent to the territorial waters of the United States. In 1947, the Supreme Court decision in *United States* v. *California* awarded the federal government jurisdiction over all U.S. ocean resources from the tidemark seaward. This judgment, highly unpopular in coastal regions, led to the passage of the Submerged Lands Act of 1953, which returned resource jurisdiction within the 3 nautical mile territorial sea to coastal states. A companion bill enacted in the same year, the Outer Continental Shelf Lands Act, authorized the Secretary of the Interior to lease federal areas of the continental shelf for oil and gas exploration and development.

From Sputnik to Stratton

On October 4, 1957, the Soviet Union launched Sputnik, the world's first space satellite. This was one of several major events that would sharply alter the direction of U.S. ocean policy during the last half of the twentieth century. The show of Soviet prowess shocked America, spurring national resolve. It seemed suddenly as if every arena of activity, from the construction of intercontinental ballistic missiles to the training of athletes for the Olympic high jump, had become a test of dueling national wills. The foremost areas of competition were technology and science.

In 1959, the National Research Council released a report that recommended doubling the federal government's commitment to oceanography, building a new research fleet, and forging stronger partnerships with academic institutions.[1] The recommendations served as the basis for ocean policy under President Kennedy and attracted strong support from such influential senators as Warren Magnuson of Washington who warned, in the spirit of the times, "Soviet Russia aspires to command the oceans and has mapped a shrewdly conceived plan, using science as a weapon to win her that supremacy."[2]

This era of scientific enthusiasm and advancement saw the Navy and the National Science Foundation (NSF) take on critical roles in developing U.S. ocean capabilities. The post World War II period brought significant Navy investment in basic research into ocean processes, resulting in the development of most of today's oceanographic instruments. The Navy's ocean data holdings have been called the crown jewels of global oceanography, and its investment in operational ocean infrastructure has contributed greatly to U.S. ocean capability and influence in international ocean affairs. NSF came into existence at the end of World War II, largely due to the recognition that support for basic research was essential to national well being. Since that time, NSF has increasingly become the leader in support for ocean research and related infrastructure.

Through their investments in basic and applied research, operations, education and infrastructure, NSF and the Navy helped create a robust and influential ocean research community in the United States.

In the 1960s, faith in the power of science was at its apogee. Said *Time* magazine:

> U.S. scientists and their colleagues in other free lands are indeed the true 20th century adventurers, the explorers of the unknown, the real intellectuals of the day, the leaders of mankind's greatest inquiry into the mysteries of matter, of the earth, the universe and of life itself. Their work shapes the life of every human presently inhabiting the planet, and will influence the destiny of generations to come.[3]

In this context, the appetite for exploring the unknown was seemingly insatiable, applying not only to outer space but also to inner space—the mysterious depths of the sea. In addition to ongoing investments in ocean research by the Navy and NSF, in 1966 Congress created a National Sea Grant College program within NSF, based on the long-established model of Land Grant colleges. After a modest beginning, Sea Grant evolved into a popular initiative within the marine science community and the public and became a prime source of support for research in marine-related subjects outside oceanography, including fisheries and law.

Support grew for the creation of an independent national ocean agency, a watery counterpart to the National Aeronautics and Space Administration. To prepare the way, Congress approved the Marine Resources and Engineering Development Act, signed by President Johnson on June 17, 1966. The Act included a declaration of U.S. policy, the formation of a national council chaired by the Vice President, and the establishment of a presidential Commission on Marine Science, Engineering and Resources. Julius Stratton, president emeritus of the Massachusetts Institute of Technology and chairman of the Ford Foundation was named as chair of that Commission.

During the next two years, the Stratton Commission's fifteen members and four congressional advisers conducted hearings and held meetings in every coastal region of the country. In January 1969, the Commission issued its report, *Our Nation and the Sea*, containing 126 recommendations.[4] The report had a catalytic impact for several reasons. It was the first truly comprehensive study of American ocean policy. It went beyond oceanography to examine a wide range of marine issues, including: the organization of the federal government; the role of the ocean in national security; the potential economic contributions of oil, gas, and other marine resources; the importance of protecting coastal and marine environments; and the need to promote American fisheries. Some recommendations were never realized (such as building offshore nuclear power plants), but others comprised the foundation for a new era in U.S. ocean policy, leading most directly to creation of the National Oceanic and Atmospheric Administration (NOAA) in 1970 and the enactment of the Coastal Zone Management Act (CZMA) in 1972.

The Stratton Commission called for the centralization of federal civilian ocean management efforts within a single new agency—envisioning a NOAA that would be independent and in charge of virtually every nonmilitary aspect of maritime policy. This did not happen. The White House budget office opposed the establishment of an independent agency, the Secretary of Transportation was unwilling to give up the Coast Guard, and the Maritime Administration remained separate. So when NOAA was born on July 9, 1970 (via Reorganization Plan #4), its prospects for thriving within the bureaucracy were slim. Lodged within the U.S. Department of Commerce, it lacked cabinet status, independence, a congressional charter, and control over many federal marine activities. NOAA did, however, become a center of federal ocean expertise, bringing together nine programs from five departments, including the Environmental Sciences Services Administration, the Bureau of Commercial Fisheries, and the Sea Grant program.

The impact of the Stratton Commission report was magnified by its timeliness. Once again, events were occurring that would guide the direction of ocean policy, this time toward greater environmental awareness. In 1966, seismic tests in the Georges Bank fishing grounds caused an explosion that halted fishing for three weeks and prompted calls for a ban on oil and gas activity in the area. In January 1969, Union Oil's Platform A in the Santa Barbara Channel blew out, spilling some 3 million gallons of oil, killing marine life, and affecting more than 150 miles of shoreline. The images of soiled beaches, oil-soaked birds, and belly-up fish generated widespread public concern and contributed to the enactment of a law that would profoundly affect the approach of the federal government to natural resources of every description—the 1969 National Environmental Policy Act (NEPA).

Years of Activism

To an extent not seen before or since, the political climate between 1969 and 1980 was ripe for initiatives to expand the federal role in ocean and environmental management. The Stratton report had sounded the trumpet, calling upon "Congress and the President to develop a national ocean program worthy of a great sea nation." Segments of the American public, aroused by the Santa Barbara oil spill and the inaugural Earth Day on April 22, 1970, lent support to a new generation of activist environmental organizations demanding federal action. Members of Congress, empowered by internal reforms that enlarged staffs and somewhat weakened the seniority system for selection of committee chairs, were eager to play a policy-making role. Internationally, the United Nations Conference on the Human Environment met in Stockholm in 1972, a milestone for the environmental movement. Both at home and overseas, the oceans were caught up in the larger pro-environment trend.

As a result, the stewardship ethic embodied by NEPA—the idea that the government should study, plan, and offer the opportunity for public comment before acting—was applied to the oceans. This principle was at the heart of the new law dealing with America's increasingly populous coastal zone. The CZMA constituted a marriage of federal activism and states' rights. Entirely voluntary, the program offered grants to states to help develop and implement coastal management plans tailored to local needs but reflecting broad national interests. To encourage states to enforce their plans, the federal government agreed to honor them as well. This pledge to make federal actions affecting the coastal zone consistent with state plans (referred to as the federal consistency provisions) was novel and would, at times, prove controversial.

Other major ocean-related legislation enacted during this period included measures to improve our nation's water quality, regulate ocean dumping, designate marine sanctuaries, prohibit the taking of marine mammals, protect endangered species, license deep-water ports, promote aquaculture, and encourage the development of ocean thermal energy conversion as a renewable source of power. The most dramatic expansion of federal ocean activity, however, resulted from enactment of the Fishery Conservation and Management Act, later renamed the Magnuson–Stevens Fishery Conservation and Management Act. According to its terms, on March 1, 1977, American fisheries jurisdiction was extended from 12 to 200 nautical miles, an expansion in area roughly equal to the size of the continental United States. This action reflected a triumph of America's interest in championing the rights of coastal nations to control resources over its interest in defending the maximum degree of freedom on the high seas.

The legislation was prompted by the anger of U.S. fishermen, especially in the North Atlantic and off Alaska, regarding the presence on their traditional fishing grounds of massive foreign factory trawlers scooping tons of fish from the sea. The trawlers, many from the Soviet Union, were able to operate at all hours, even in harsh weather, catching fish and freezing them on the spot. By the end of the 1960s, America had dropped from second to sixth in its share of world fishery catch and a substantial segment of the U.S. commercial fishing industry was in deep trouble. Compared to the large, modern, efficient Soviet trawlers, most U.S. vessels were small and inefficient. Although the U.S. Department of State urged Congress to delay action pending the outcome of global negotiations on the U.S. Law of the Sea Convention, those discussions were going slowly, and the pressure to act became overwhelming.

The management scheme created by the Magnuson–Stevens Act was imaginative, yet complicated: Regional Fishery Management Councils were appointed and required to develop and submit plans for managing particular species to the Secretary of Commerce for approval. The intention was to harness regional expertise in the national interest, make full use of scientific data, and give the industry a voice in designing the means of its own regulation. The Coast Guard was tasked with achieving the law's main selling point—foreigner fishing fleets out, Americans in—and various measures were developed to encourage new investment in the U.S. fishing fleet. The explicit intent of the statute was to prevent overfishing, rebuild overfished stocks, and realize the full potential of the nation's fishery resources. Despite the challenge of persuading fiercely independent fishermen to accept restrictions on their activities, there was much optimism in the early years that the Magnuson–Stevens Act's ambitious goals would be met.

Meanwhile, policy makers were coping with another pressing concern: the Arab oil embargo triggered by the 1973 Middle East war had a direct impact on the lives of millions of Americans. Heating costs soared, and the simple act of filling up at the local gas station turned into a nightmare. The country's vulnerability to disruptions caused by dependence on uncertain supplies of foreign oil became a major economic and national security issue. In response, the Nixon administration proposed a massive expansion of outer Continental Shelf (OCS) oil and gas leasing to include frontier areas off the Atlantic, Gulf, and Pacific coasts. This proposal ran counter to the pro-environmental currents then circulating, and posed a challenge to lawmakers searching for a way to address ecological and energy supply concerns simultaneously. The result was the OCS Lands Act Amendments of 1978, the product of three years of bipartisan legislative effort, designed to encourage leasing subject to new planning requirements, more rigorous environmental standards, and measures to ensure that the views of state and local governments were taken into account.

The many ocean-related laws spawned during the 1970s addressed urgent needs, introduced creative management concepts, and multiplied the scope of federal responsibility. But they lacked an overarching vision critical to a coherent national ocean policy. NOAA was neither equipped nor authorized to set priorities across more than a small portion of the spectrum of marine activities, and most of the laws enacted were aimed at a single purpose or ocean use, and implemented with little reference to others.

The inherent difficulty of managing diverse activities over a vast geographic area, and the incremental manner in which the federal ocean regime was assembled, inevitably resulted in fragmentation. The three presidents who served between 1969 and 1981 did not provide strong policy direction on ocean issues. In the absence of such direction, neither the executive branch nor Congress was structured in a way that fostered a comprehensive approach to the oceans. No federal department could claim the lead, and crosscutting legislative initiatives were referred to multiple congressional committees where differing perspectives tended to cancel each other out. Notwithstanding the Stratton Commission's call for centralization, by 1980 federal responsibility for ocean-related programs was distributed among ten departments and eight independent agencies.

Contention and Stalemate

The 1981 inauguration of President Reagan altered the direction of America's approach to maritime issues. For the first time since the days of Presidents Kennedy and Johnson, the White House was the source of clear policy direction for the oceans. While the consensus in the 1970s had favored a larger federal role, the new administration wanted to reduce the size of government. While legislation approved in the 1970s called for a steady increase in investments to achieve marine-related goals, the Reagan philosophy called for cutbacks. While the mood of the 1970s leaned heavily in the direction of environmental protection, the new administration favored a minimum of restrictions on the private sector.

U.S. Department of the Interior (DOI) Secretary James Watt departed from the earlier practice of offering limited offshore areas for energy leases and proposed instead opening practically the entire outer continental shelf simultaneously. During his first eighteen months in office, 265 million acres were offered for lease. At the same time, the administration proposed to eliminate funding for the Sea Grant and Coastal Zone Management programs, reduce investments in oceanographic research, and privatize a number of functions carried out by NOAA. Congress responded to Secretary Watt's proposals by including a provision in the 1982 DOI appropriations bill that prohibited it from leasing certain offshore areas. This practice of legislating moratoria soon took hold, leading eventually to 50 nautical mile no-leasing buffer zones along much of the Atlantic and Pacific coasts. President Reagan's successors later removed almost all new areas from leasing consideration through 2012. As the OCS program gyrated from one extreme to the other, the balanced approach Congress sought when amending the OCS Lands Act in 1978 was never fully tested, despite the still-compelling need for secure energy supplies.

The Reagan administration also changed the tenor of American ocean policy internationally. Since 1958, efforts had been underway to negotiate a convention on the law of the sea spelling out a global consensus on such matters as freedom of navigation, fisheries jurisdiction, continental shelf resources, and the width of the territorial sea. At the request of less developed nations, the third round of negotiations, begun in 1973, included consideration of an elaborate international regime to govern the mining of minerals from the deep seabed in areas outside the jurisdiction of any country. Advocates argued that minerals found beneath international waters should be considered part of the Common Heritage of Mankind, with revenues shared on a global basis. The Reagan administration, with support from many in both parties of Congress, argued that the deep seabed was a frontier area that should be open to exploration and exploitation without a requirement to share profits. When the Law of the Sea negotiations concluded in 1982, the United States was one of the few countries to vote against the resulting convention.

Despite this, the administration soon took two steps recognizing provisions in the convention that the United States did support. In 1983, President Reagan declared a 200 nautical mile exclusive economic zone (EEZ), changing what had been a continental shelf and fishery resource jurisdictional system into an exclusive regime governing access to all ocean and continental shelf resources, including the water column itself (though not impeding the right to free navigation). Five years later, the United States officially extended its territorial sea from 3 to 12 nautical miles. The administration, however, did not offer any significant plans for exploring or exercising a new management role in these areas.

The architects of ocean-related programs in the 1970s built on the foundation of the Stratton Commission, creating a multidimensional framework for the management of America's stake in the oceans. The Reagan administration saw much of that framework as unrelated to—or even interfering with—the core government functions of national defense and fostering free enterprise. The result was an ongoing clash that ratified the vision of neither side, producing a stalemate. The administration did not succeed in eliminating programs such as Sea Grant and Coastal Zone Management, but it was able to hold the line or reduce financial support for most of them. Funding for NOAA's ocean research, for example, declined from $117.9 million in 1982 to $40.7 million in 1988. Many managers, earlier preoccupied with implementing their programs, spent much of the 1980s trying to save them.

Search for Coherence

Recent years have been characterized neither by the rapid growth in federal ocean activity characteristic of the 1970s, nor by the change in course that took place in the 1980s. The *EXXON Valdez* oil spill in Prince William Sound, occurring a few months after President George H.W. Bush took office in 1989, helped revive support for environmentally protective legislation. The spill led directly to enactment of the 1990 Oil Pollution Act, mandating double hulls for tankers carrying oil in U.S. waters by 2015 and setting liability standards for oil spills. That same year, amendments to the CZMA clarified that OCS lease sales are subject to the federal consistency provisions of the statute. Frustrated by the persistence of marine pollution, Congress continued to search for effective ways to reduce pollution from nonpoint sources, such as urban runoff and agriculture. Mounting alarm about the depletion of major groundfish stocks, despite two decades of management under the Magnuson–Stevens Act, led to the 1996 Sustainable Fisheries Act, designed to prevent overfishing.

On the world stage, the United Nations Conference on Environment and Development—the Earth Summit—held in Rio de Janeiro in 1992 made recommendations in seven program areas dealing with the conservation of marine and coastal resources. It also produced the United Nations Framework Agreement on Climate Change (ratified by the United States in 1992) and the United Nations Convention on Biological Diversity (which the United States has not ratified). In 1994, an agreement was reached addressing U.S. concerns on implementing the deep seabed mining provisions of the United Nations Convention on the Law of the Sea, and the Clinton administration sent the treaty to the Senate for advice and consent, where it still lingers, though it is in force internationally.

The dominant trend in U.S. ocean policy in the 1990s was a growing sense of dissatisfaction with the ad hoc approach. Much had changed since the Stratton Commission report was issued in 1969. New opportunities, such as offshore aquaculture and marine biotechnology, were being held back by the lack of an appropriate management structure to guide development. Pressures on ocean and coastal areas continued to intensify and new threats loomed, such as sea level rise and increased storm frequency attributable to global climate change, as well as puzzling and sometimes deadly algal blooms. The link between science and policy that had seemed so essential and exciting to the nation in the 1960s now suffered from insufficient investment and high-level neglect. On many key ocean issues, debate was leading not to consensus, but rather to heightened disagreements that could not be resolved under existing laws and arrangements, and often to litigation.

The sense of partial paralysis was strengthened by the existence through most of the decade of divided government, with different parties in control of the White House and Congress. None of the many centers of power was able to lead with sustained success. In search of coherence, panels assembled by the National Research Council, as well as expert groups brought together under other auspices, recommended a detailed study of the nation's ocean-related laws, programs, activities, and needs.

Consensus for Change

Since the publication of the Stratton Commission's report, seventeen Congresses and seven presidents have created, expanded, and remodeled the current framework of laws governing ocean and coastal management. At last count, more than 60 congressional committees and subcommittees oversee some 20 federal agencies and permanent commissions in implementing at least 140 federal ocean-related statutes.

Recognition of the growing economic importance and ecological sensitivity of the oceans and coasts, our responsibility to future generations, and the inadequacies of the current management regime set the stage for enactment of the Oceans Act of 2000 (Appendix A), establishing the U.S. Commission on Ocean Policy in August 2000. Although publicly financed, the Commission is fully independent and is charged with carrying out the first comprehensive review of marine-related issues and laws in more than thirty years to assist the nation in creating a truly effective and farsighted ocean policy.

In enacting the Oceans Act, Congress cited the pressing need for a coherent national system of ocean governance. Factors contributing to this need include rising coastal populations, increased competition for ocean space, demand for port facilities, the emergence of potential new ocean uses, the decline of vital commercial fishery stocks, unresolved debates over offshore energy and mineral development, the persistence of marine pollution, the contamination of seafood, the loss of coastal wetlands, and the prospect that enhanced knowledge of the oceans will improve our ability to comprehend the causes of climate variability and other not yet fully grasped environmental threats.

The Commission was established because the nation is not now sufficiently organized legally or administratively to make decisions, set priorities, resolve conflicts, and articulate clear and consistent policies that respond to the wealth of problems and opportunities ocean users face. In the words of the Senate Committee on Commerce, Science and Transportation: "Today, people who work and live on the water, from fishermen to corporations, face a patchwork of confusing and sometimes contradictory federal and state authorities and regulations. No mechanism exists for establishing a common vision or set of objectives."[5]

In September 2001, a major event again altered the lens through which America views ocean policy. Terrorist attacks on U.S. soil resulted in the placement of a higher priority on maritime security issues. That very month, the Commission's initial organizational meeting was held. The Coast Guard was soon transferred to the new U.S. Department of Homeland Security. Meanwhile, partly as a result of the war on terror, constraints on the domestic discretionary part of the U.S. government's budget raised new questions not only about what U.S. ocean policy should be, but also about what policy choices the nation can afford.

LAUNCHING THE U.S. COMMISSION ON OCEAN POLICY

A Broad Mandate

The Commission was directed to address numerous challenging issues ranging from the stewardship of fisheries and marine life to the status of knowledge about the marine environment, as well as the relationships among federal, state, and local governments and the private sector in carrying out ocean and coastal activities. The Oceans Act requires that the Commission suggest ways to reduce duplication, improve efficiency, enhance cooperation, and modify the structure of federal agencies involved in managing the oceans and coasts.

With input from the states, a science advisory panel, and the public, the Commission was instructed to prepare a report presenting recommendations to the president and Congress on ocean and coastal issues for the purpose of developing a coordinated and comprehensive national ocean policy. The Oceans Act states that this national ocean policy should promote protection of life and property, responsible stewardship of ocean and coastal resources, protection of the marine environment and prevention of marine pollution, enhancement of marine commerce, expansion of human knowledge of the marine environment, investment in technologies to promote energy and food security, close cooperation among government agencies, and preservation of U.S. leadership in ocean and coastal activities. In developing its recommendations, the Commission must give equal consideration to environmental, technical feasibility, economic, and scientific factors.

Specifically, the Commission's report was required to include the following elements:

- an assessment of ocean facilities including vessels, people, laboratories, computers, and satellites (Appendix 5);
- a review of the cumulative effect of federal laws (Appendix 6);
- a review of the supply and demand for ocean and coastal resources;
- a review of the relationships among federal, state, and local governments and the private sector;
- a review of the opportunities for investment in new products and technologies;
- recommendations for modifications to federal laws or the structure of federal agencies; and
- a review of the effectiveness of existing federal interagency policy coordination.

Finally, the Oceans Act requires the Commission to solicit comments from the governors of coastal states and include those comments in its final report. This preliminary report has been created specifically to fulfill that purpose.

The Commission Members

In accordance with guidelines set forth in the Oceans Act, in July 2001 President George W. Bush appointed sixteen citizens knowledgeable in ocean and coastal activities to serve on the U.S. Commission on Ocean Policy. The President selected twelve members from lists submitted by the Senate Majority Leader, the Senate Minority Leader, the Speaker of the House of Representatives, and the Minority Leader of the House. The remaining four members were chosen directly by the President. The Commission members (listed at the front of this report) come from positions and diverse professional backgrounds in: federal, state and local governments; private industry; and academic and research institutions involved in marine-related issues. Admiral James D. Watkins, USN (Retired), was elected chairman by his fellow commissioners at the first Commission meeting.

How the Commission Did Its Work

This report was developed after careful consideration of materials gathered during public meetings, through public comment, from existing literature, and through input of science advisors and other noteworthy experts. The input received from all of these sources served to guide the development of this report.

Regional Meetings

Because of the vast scope of topics the Commission was required to address, it sought input from a wide range of experts across the country. After two initial organizing meetings in Washington, D.C., the Commission heard testimony on ocean and coastal issues in nine different areas around the United States during a series of regional meetings and related site visits. The Commission was required to hold at least one public meeting in Alaska, the Northeast (including the Great Lakes), the Southeast (including the Caribbean), the Southwest (including Hawaii and the Pacific Territories), the Northwest, and the Gulf of Mexico. To obtain information from an even greater segment of U.S. marine-related interests, the commissioners held three additional regional meetings. The commissioners also learned about important regional issues through site visits (Table 2.1).

The public meetings provided government agencies, nongovernmental organizations, industry, academia, and the public the opportunity to directly discuss ocean and coastal concerns with the Commission. Commissioners held dialogues with invited speakers and sought comments from members of the public to gain insight into issues and opportunities facing each region, and to solicit recommendations for Commission consideration. The regional meetings highlighted relevant case studies and regional models with potential national applicability.

Invited panelists were selected based on their expertise on the topics highlighted at each meeting, with a strong effort to maintain a balance of interests and gain perspectives from all sectors (Figure 2.2). Four additional public meetings were held in Washington, D.C., after completion of the regional meetings. At the last few meetings, the commissioners publicly presented and discussed many of the policy options that served as the foundation for the Commission's recommendations. Overall during its fifteen public meetings, the Commission heard from some 445 witnesses, including over 275 invited presentations and an additional 170 comments from the public, resulting in nearly 1,900 pages of testimony (Appendices 1 and 2).

Table 2.1. Public and Regional Meetings of the U.S. Commission on Ocean Policy
The commissioners held fifteen public meetings and conducted seven regional site visits to examine a wide range of important issues and gain input from local, state, and regional ocean communities throughout the United States.

Washington, D.C.
September 17–18, 2001

Washington, D.C.
November 13–14, 2001

Southeast—Delaware to Georgia
January 14–16, 2002:
January 14: Regional site visits (Annapolis, MD; Charleston, SC)
January 15–16: Public meetings in Charleston, SC

Florida and the Caribbean
February 21–22, 2002:
February 21: Regional site visits (Puerto Rico; South Florida East Coast; West Coast, Tampa–Sarasota)
February 22: Public meetings in St. Petersburg, FL

Gulf of Mexico—Alabama to Texas
March 6–8, 2002:
March 6: Regional site visits (Texas A&M University, February 19; offshore New Orleans, LA; Stennis Space Center, MS)
March 7–8: Public meetings in New Orleans, LA

Southwest—California
April 17-19, 2002:
April 17: Regional site visits (San Diego and Monterey, CA)
April 18–19: Public meetings in San Pedro, CA

Hawaii and Pacific Islands
May 13–14, 2002:
May 13–14: Public meetings in Honolulu, HI

Northwest—Washington and Oregon
June 12–14, 2002:
June 12: Regional site visits (Olympia and Seattle, WA)
June 13–14: Public meetings in Seattle, WA

Northeast—New Jersey to Maine
July 22–24, 2002:
July 22: Regional site visits (southern New England; New York–New Jersey; northern New England)
July 23–24: Public meetings in Boston, MA

Alaska
August 21–23, 2002:
August 21–22: Public meetings in Anchorage, AK
August 23: Regional site visits (Dutch Harbor and Juneau, AK)

Great Lakes
September 23–25, 2002:
September 24–25: Public meetings in Chicago, IL

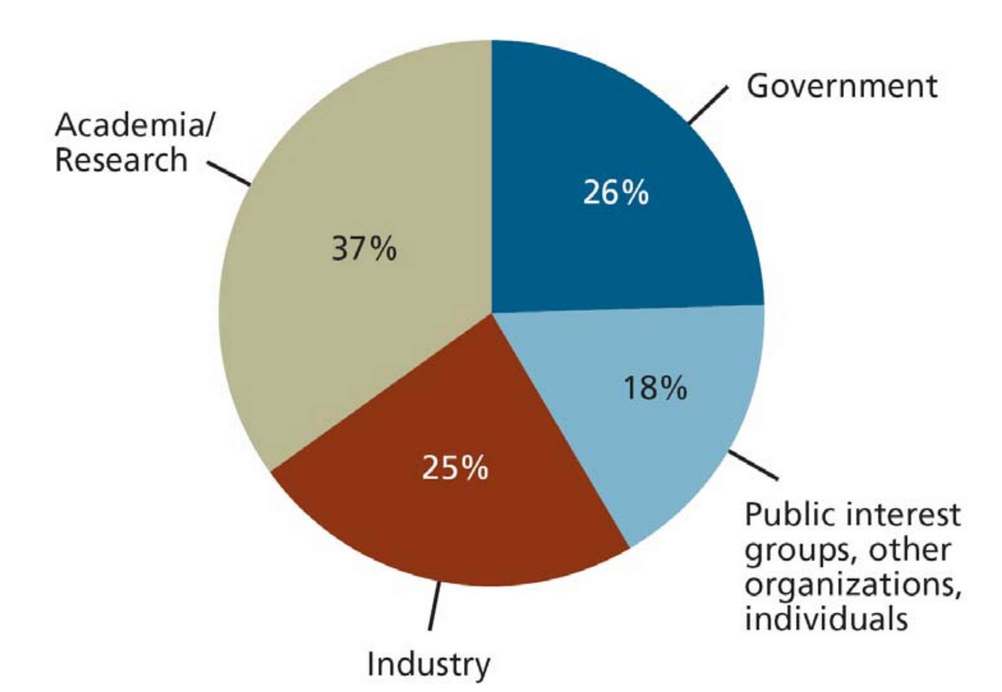
Washington, D.C.
October 30, 2002

Washington, D.C.
November 22, 2002

Washington, D.C.
January 24, 2003

Washington, D.C.
April 2–3, 2003

Figure 2.2. Invited Panelists Represented all Sectors of the Ocean Community



This breakdown of the panelists invited to present testimony before the U.S. Commission on Ocean Policy during its public meetings, held from September, 2001 to November, 2002, illustrates the breadth of input received.

Working Groups

During the first Commission meeting in September 2001, the commissioners agreed to establish four working groups in the areas of: Governance; Stewardship; Research, Education, and Marine Operations; and Investment and Implementation. These working groups were charged with reviewing and analyzing issues within their area and reporting their findings to the full Commission.

Based on extensive reviews of the testimony, public comments, background papers prepared by expert consultants, existing literature, and discussions with a broad cross-section of the marine-related community, the working groups identified key issues and outlined possible options for addressing them. The working groups shared their work with each other throughout the deliberative process to ensure thorough integration and coordination in developing the final Commission report and recommendations.

The Governance Working Group examined the roles of federal, state, and local governments as they relate to the oceans. It also assessed the management of the coastal zone and nonliving marine resources and provided options for improvement.

The Stewardship Working Group addressed living marine resources, pollution, and water quality issues and assessed the current status of ocean stewardship, the behavior of people with respect to the oceans, and incentives for responsible actions. The group concentrated on actions to achieve responsible and sustainable use of the ocean and its resources.

The Research, Education, and Marine Operations Working Group examined ocean and coastal research, exploration, air-ocean interaction research, education, marine operations, and related technology and facilities.

This group analyzed the current status in these areas to assess their adequacy in achieving the national goals set forth in the Oceans Act.

Finally, the Investment and Implementation Working Group discussed the new investment and implementation strategies needed to carry out the Commission's proposed ocean policy. This working group concentrated on answering the question, "Given the recommendations from the other working groups, what federal structures, processes, or investments are necessary to integrate, implement, and sustain the Commission's recommendations?"

Science Advisory Panel

The Oceans Act directed the Commission, with assistance from the National Academy of Sciences, to establish a multidisciplinary science advisory panel consisting of experts in living and nonliving marine resource issues from outside the federal government. The panel, listed at the front of this report, included many of the finest ocean science and marine policy practitioners and researchers in the nation and reflected the breadth of issues before the Commission. Panel members provided expert advice on a range of issues and reviewed draft materials to ensure the Commission's report was based on the best scientific information available.

Other Sources of Information

Throughout its work, the Commission continuously sought advice from experts on specific issues of concern through formal seminars and conferences, informal meetings and discussions, and preparation of background reports. Striving to maintain communication with all interested parties and to gain knowledge from a range of sources, the Commission also encouraged members of the public to submit information for the official record throughout the Commission's fact-finding and deliberative phases. An active Web site was maintained to facilitate public input.

As a result of the Commission's outreach efforts, more than 3,000 pages of information have been filed in the official Commission record. This vast wealth of accumulated information provided examples of successful approaches and formed the basis for the Commission's recommendations.

The Result

This report of the U.S. Commission on Ocean Policy, along with its extensive appendices, is the culmination of more than two years of discussion, deliberation, review, and refinement. It represents a consensus of the sixteen Commission members on the best course of action this nation should take to realize a coordinated and comprehensive national ocean and coastal policy. Meaningful change will require a reorientation of political, economic, and social attitudes and behaviors. Such change is likely to take time, but it must begin now if we are to reverse a continuing decline in the health and economic vitality of ocean and coastal waters.

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Chapter 3:
Setting the Nation's Sights

The first step in any call for change should be to paint a picture of the desirable end result and specify the principles that will guide the changes. For U.S. ocean policy to improve, it must be based on a positive vision for the future, broad guiding principles, and translation of those principles into an effective governance system with working policies and programs. In keeping with the latest scientific understanding about the world, management based on ecosystems rather than political boundaries should be at the heart of any new ocean policy framework. Success also depends on greatly improved public awareness of the relationship between the oceans and human existence, the connections among the land, air, and sea, the balance of benefits and costs inherent in using ocean and coastal resources, and the role of governments and citizens as ocean stewards.

Imagining a Brighter Future

The potential benefits associated with oceans and coasts are vast; however, the problems we face in protecting them and realizing their full potential are numerous and complex. There is a growing awareness of the connectivity within and between ecosystems and the impacts of human activities on the marine environment. The need for change emerged as a compelling theme at each of the U.S. Commission on Ocean Policy's public meetings—change not only in management and policies, but also in public awareness and education, and in the use of science and technology. However, before attempting to reform any system, it is important to identify the desired result. What would an improved ocean management system achieve? What would be its most important attributes? How would the oceans and coasts benefit from this improved system? What would the world look like after such reforms were realized?

In the desirable future, the oceans and coasts would be clean, safe, and sustainably managed. The oceans would contain a high level of biodiversity and contribute significantly to the economy, supporting multiple beneficial uses, including food production, development of energy and mineral resources, recreation, transportation of goods and people, and the discovery of novel life-saving drugs and other useful products. The coasts would be attractive places to live, work and play, with clean water and beaches, easy public access, vibrant economies, safe bustling harbors and ports, adequate roads and services, and special protection for sensitive habitats. Beach closings, toxic algal blooms, proliferation of invasive species, and vanishing native species would be rare. Better land use planning and improved predictions of severe weather and other natural hazards would save lives and money.

In the desirable future, management of the oceans and coasts would follow ecosystem boundaries, looking at interactions among all elements of the system, rather than addressing isolated areas or problems. In the face of scientific uncertainty, managers would balance competing considerations and proceed with caution. Ocean governance would be effective, participatory, and well coordinated among government agencies, the private sector, and the public.

An improved ocean governance framework would recognize the critical importance of good information and provide strong support for physical, biological, social, and economic research. Investments would be made in the tools and technologies needed to conduct this research: ample, well-equipped surface and underwater research vessels; reliable, sustained satellites; state-of-the-art computing facilities; and innovative sensors that withstand harsh ocean conditions. A widespread network of observing and monitoring stations would provide data for research, planning, marine operations, timely forecasts, and periodic assessments. Scientific findings and observations would be translated into practical information, maps, and products used by decision makers and the public.

Better education would be a key element of the desirable future, with the United States once again joining the top ranks in math, science, and technology achievement. An ample, well-trained, and motivated workforce would be available to study the oceans, set wise policies, apply technological advances, engineer new solutions, and teach the public about the value and beauty of the oceans and coasts throughout their lives. As a result of this lifelong education, people would understand the links among the land, sea, air, and human activities and would be better stewards of the nation's resources.

Finally, the United States would be a leader and full partner globally, sharing its science, engineering, technology, and policy expertise, particularly with developing countries, to facilitate the achievement of sustainable ocean management on a global level.

The Commission believes this vision is practical and achievable.

Building Ocean Policy on Sound Guiding Principles

To achieve the vision, national ocean policy should be guided by a set of overarching principles. Although existing ocean policies address specific issues or resources with varying degrees of success, there are no broad principles in place to guide the development and implementation of new policies, provide consistency among the universe of different policies, and assess the effectiveness of any particular policy. The fundamental principles that should guide ocean policy include the following:

- **Sustainability:** Ocean policy should be designed to meet the needs of the present generation without compromising the ability of future generations to meet their needs.
- **Stewardship:** The principle of stewardship applies both to the government and to every citizen. The U.S. government holds ocean and coastal resources in the public trust—a special responsibility that necessitates balancing different uses of those resources for the continued benefit of all Americans. Just as important, every member of the public should recognize the value of the oceans and coasts, supporting appropriate policies and acting responsibly while minimizing negative environmental impacts.
- **Ocean–Land–Atmosphere Connections:** Ocean policies should be based on the recognition that the oceans, land, and atmosphere are inextricably intertwined and that actions that affect one Earth system component are likely to affect another.
- **Ecosystem-based Management:** U.S. ocean and coastal resources should be managed to reflect the relationships among all ecosystem components, including humans and nonhuman species and the environments in which they live. Applying this principle will require defining relevant geographic management areas based on ecosystem, rather than political, boundaries.
- **Multiple Use Management:** The many potentially beneficial uses of ocean and coastal resources should be acknowledged and managed in a way that balances competing uses while preserving and protecting the overall integrity of the ocean and coastal environments.

- **Preservation of Marine Biodiversity:** Downward trends in marine biodiversity should be reversed where they exist, with a desired end of maintaining or recovering natural levels of biological diversity and ecosystem services.
- **Best Available Science and Information:** Ocean policy decisions should be based on the best available understanding of the natural, social, and economic processes that affect ocean and coastal environments. Decision makers should be able to obtain and understand quality science and information in a way that facilitates successful management of ocean and coastal resources.
- **Adaptive Management:** Ocean management programs should be designed to meet clear goals and provide new information to continually improve the scientific basis for future management. Periodic reevaluation of the goals and effectiveness of management measures, and incorporation of new information in implementing future management, are essential.
- **Understandable Laws and Clear Decisions:** Laws governing uses of ocean and coastal resources should be clear, coordinated, and accessible to the nation's citizens to facilitate compliance. Policy decisions and the reasoning behind them should also be clear and available to all interested parties.
- **Participatory Governance:** Governance of ocean uses should ensure widespread participation by all citizens on issues that affect them.
- **Timeliness:** Ocean governance systems should operate with as much efficiency and predictability as possible.
- **Accountability:** Decision makers and members of the public should be accountable for the actions they take that affect ocean and coastal resources.
- **International Responsibility:** The United States should act cooperatively with other nations in developing and implementing international ocean policy, reflecting the deep connections between U.S. interests and the global ocean.

Translating Principles into Policy

While articulating a vision for the future and identifying fundamental principles are necessary first steps, these must then be translated into working policies and programs. Four concepts serve as guideposts for developing and implementing new ocean policies: ecosystem-based management; incorporation of scientific information in decision-making; improved governance; and broad public education.

Ecosystem-based Management

Sound ocean policy requires managers to simultaneously consider the economic needs of society, the need to protect the nation's oceans and coasts, and the interplay among social, economic, and ecological factors. These factors are closely intertwined, just like the land, air, sea, and marine organisms. Activities that affect the oceans and coasts may take place far inland. For example, land-based sources of pollution, such as runoff from farms and city streets, are a significant source of the problems that plague marine ecosystems. Ocean policies cannot manage one activity, or one part of the system, without considering its connections with all the other parts. Thus, policies governing the use of U.S. ocean and coastal resources must become ecosystem-based, science-based, and adaptive.

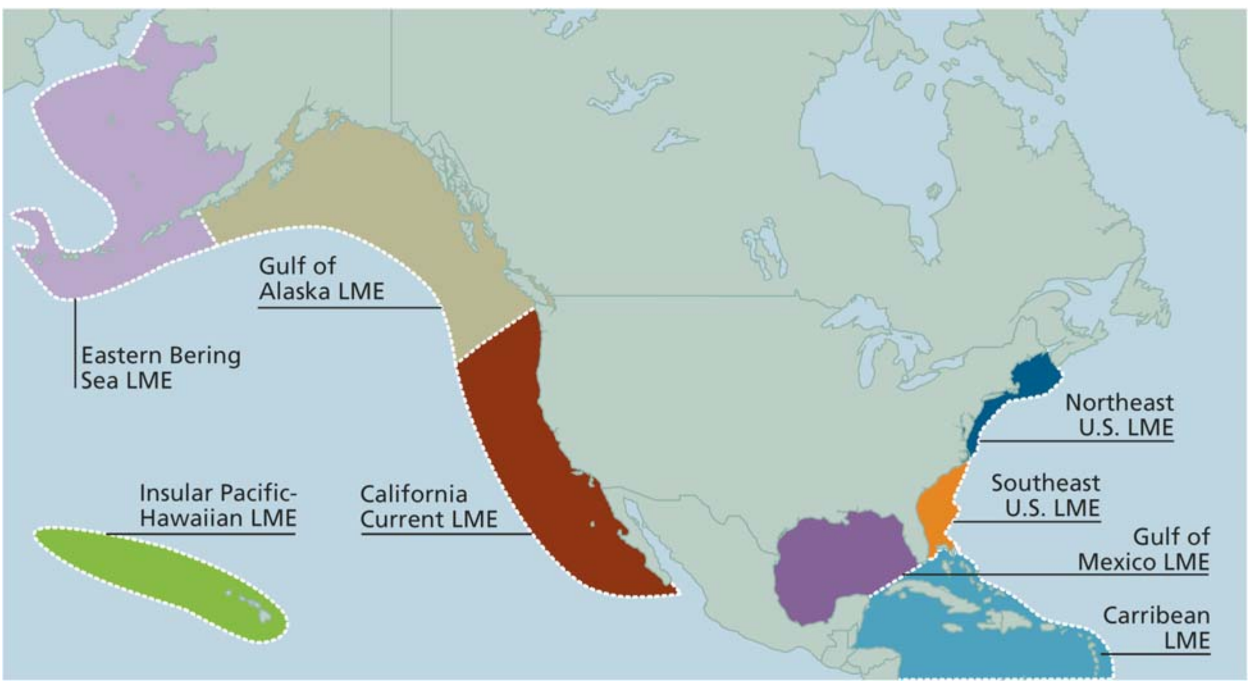
Ecosystem-based management looks at all the links among living and nonliving resources, rather than considering single issues in isolation. This system of management considers human activities, their benefits, and their potential impacts within the context of the broader biological and physical environment. Instead of developing a management plan for one issue (such as a commercial fishery or an individual source of pollution), ecosystem-based management focuses on the multiple activities occurring within specific areas that are defined by ecosystem, rather than political, boundaries.

Defining New Management Boundaries

Splitting the natural world into clearly defined management units is a somewhat arbitrary process. Existing management boundaries primarily follow political lines. However, new scientific understanding of ecosystems makes it possible to design management areas that conform more closely to ecological units.

Since the 1960s, scientists have developed and refined the concept of "large marine ecosystems." These regions divide the ocean into large functional units based on shared bathymetry, hydrography, productivity, and populations and encompass areas from river basins and estuaries to the outer edges of continental shelves and seaward margins of coastal current systems (Figure 3.1).[1] Large marine ecosystems are not currently used as management boundaries, although they were a basis for the fishery management regions defined by the Magnuson–Stevens Fishery Conservation and Management Act. On land, watersheds have generally been identified as appropriate ecosystem-based management units, particularly for issues related to hydrology and water pollution. Because of the connection between land-based activities and ocean conditions, an appropriate geographic boundary for ecosystem-based management of ocean areas would combine large marine ecosystems with the watersheds that drain into them.

Figure 3.1. Large Marine Ecosystems Correspond to Natural Features



As the map indicates, eight large marine ecosystems (LMEs) have been identified for the United States. These LMEs are regions of the ocean encompassing coastal areas out to the seaward boundaries of continental shelves and major current systems and take into account the biological and physical components of the marine environment as well as terrestrial features, such as river basins and estuaries, that drain into these ocean areas.
Source: University of Rhode Island Environmental Data Center, Department of Natural Resources <http://mapper.edc.uri.edu/website/lmeims/viewer.htm> (Accessed January, 2004).

While determining appropriate new boundaries is necessary for ecosystem-based management, it is also important to maintain sufficient flexibility to manage on both larger and smaller scales when necessary. For example, air pollution problems must be dealt with on national and even international levels, while certain water pollution issues may need to be addressed on a small-scale watershed level. Managers should be able to adapt to the scale of different activities and the ecosystems they affect.

Aligning Decision-making within Ecosystem Boundaries

The current political and issue-specific delineation of jurisdictional boundaries makes it difficult to address complex issues that affect many parts of the ecosystem. Economic development in a coastal area may fall under the jurisdiction of several local governments, and natural resource management under the jurisdiction of one or more states, while pollution control and environmental monitoring of the same area may be overseen by several federal agencies. Yet water, people, fish, marine mammals, and ships flow continually across these invisible institutional borders.

Ecosystem-based management can provide many benefits over the current structure. The coordination of efforts within a specific geographic area allows agencies to reduce duplication and maximize limited resources. It also provides an opportunity for addressing conflicts among management entities with different mandates. Less obvious, but equally important, ecosystem-based management may engender a greater sense of stewardship among government agencies, private interests, and the public by promoting identification and connection with a specific area.

Finally, ecosystem-based management makes it easier to assess and manage the cumulative impacts of many different activities. For example, the U.S. Army Corps of Engineers' wetlands permitting program has been criticized for not evaluating cumulative impacts in its review of individual dredge-and-fill permits. A true ecosystem-based management approach would ameliorate this fragmented approach.

While ecosystem-based management is being attempted in some places on a limited basis, applying it broadly and successfully will take time and effort. In particular, the transition to such management will require explicit recognition of the uncertainty of current information and understanding. This uncertainty creates risks. One widely accepted guideline for managing in the face of uncertainty and risk is to adopt a precautionary and adaptive approach.

Precautionary and Adaptive Management

Scientific uncertainty has always been, and will probably always be, a reality of the management process. Because scientists cannot predict the behavior of humans or the environment with 100 percent accuracy, managers cannot be expected to manage with complete certainty. Nevertheless, scientists *can* provide managers with an estimate of the level of uncertainty associated with the information they are providing. Managers must incorporate this level of uncertainty into the decision-making process, support the research and data collection needed to reduce the uncertainties, and be prepared to adapt their decisions as the information improves.

The *precautionary principle* has been proposed by some parties as a touchstone for managers faced with uncertain scientific information. In its strictest formulation, the precautionary principle states that when the potentially adverse effects of a proposed activity are not fully understood, the activity should not be allowed to proceed. While this may appear sensible at first glance, its application could lead to extreme and often undesirable results. Because scientific information can never fully explain and predict all impacts, strict adoption of the precautionary principle would prevent most, if not all, activities from proceeding.

In contrast to the precautionary principle, the Commission recommends adoption of a more balanced *precautionary approach* that weighs the level of scientific uncertainty and the potential risk of damage as part of every management decision. Such an approach can be explained as follows:

> **Precautionary Approach:** To ensure the sustainability of ecosystems for the benefit of future as well as current generations, decision makers should follow a balanced precautionary approach, applying judicious and responsible management practices based on the best available science and on proactive, rather than reactive, policies. Where threats of serious or irreversible damage exist, lack of full scientific certainty shall not be used as a justification for postponing action to prevent environmental degradation. Management plans and actions based on this precautionary approach should include scientific assessments, monitoring, mitigation measures to reduce environmental risk where needed, and periodic reviews of any restrictions and their scientific bases.

According to this approach, scientific uncertainty—by itself—should neither prevent protective measures from being implemented nor prevent uses of the ocean. Managers should review the best available science and weigh decisions in light of both the level of scientific uncertainty and the potential for damage. When the level of uncertainty is low and the likelihood of damage is also low, the decision to proceed is clearly supported. At the other extreme, when the level of uncertainty is high and the potential for irreversible damage is also high, managers should clearly not allow a proposed action to proceed. In the real world, managers will most likely face decisions between these two extremes, where the correct outcome will require balancing competing interests, using the best available information despite considerable uncertainty, and imposing some limits or mitigation measures to prevent environmental damage. After a decision is made, managers must continue to gather the information needed to reduce uncertainty, periodically assess the situation, and modify activities as appropriate.

Goals and Objectives for Ecosystem-based Management Plans

As with any major, complex undertaking, ecosystem-based management should be guided by clear, measurable goals and objectives. These goals should cover multiple uses and should be based on a combination of policy judgments, community values, and science. Although good science is essential for solving problems and scientists should advise managers about the consequences of various courses of action, science cannot determine the "best" outcome in the absence of clearly identified management goals. The setting of goals and objectives will depend on a blending of values and information.

Where multiple desirable but competing objectives exist, it is not possible to maximize each. For example, both recreational boating and marine aquaculture are potential uses of nearshore marine waters. Both provide benefits and costs to society, and both have impacts on the environment that can be lessened with proper planning. However, these activities can also conflict with each other: a large-scale aquaculture operation would prevent access by recreational boaters to certain waters. Science can inform managers of the potential positive or negative impacts of each activity but cannot ultimately determine whether to favor aquaculture or boating. Instead, a community judgment must be made, weighing the value of each activity against its potential impacts.

Ecosystem-based management will lead to better decisions that protect the environment while balancing multiple uses of ocean areas. Managers will need to work with the scientific community to develop the information and understanding needed to support such complex decisions. But the critical process of setting goals to guide management will require active participation by many different stakeholders with divergent views. This will be difficult to achieve without changes to the existing governance system.

Biodiversity

One of the central goals for ecosystem-based management should be the explicit consideration of biodiversity on species, genetic, and ecosystem levels. While humans have always depended on particularly valued marine species for food, medicine, and other useful products, there has been a tendency to ignore species that do not have a clear, recognizable impact on society. However, it is now understood that every species makes some contribution to the structure and function of its ecosystem. Thus, an ecosystem's survival may well be linked to the survival of all species that inhabit it.

Species diversity, or the number of species within an ecosystem, is one measure of biodiversity. However, biodiversity is also significant at larger and smaller scales. Within a single-species population, it is important to preserve *genetic diversity*—the bedrock of evolution. Maintaining genetic diversity is important for species to adapt to changing environmental conditions. It is also important to understand and protect *ecosystem diversity,* the number of different ecosystems, and different kinds of ecosystems, on Earth.

Because scientists have tended to study specific habitats, such as coral reefs, mangroves, or wetlands, quantitative measures of marine biodiversity at larger scales are rare. Nevertheless, there is broad consensus that the biodiversity of life in the oceans is being affected by human activities. Studies indicate that in many marine and coastal locations, community composition has changed to conditions that are less valuable from ecological, economic, and even cultural perspectives.[2] There have been reductions in food and medicinal species and alterations of aesthetic and recreational values important to humans, including much greater abundance of less desirable species like toxic algae and bacteria.

Despite the importance of biodiversity to ecosystem functions and values, we still know very little about how biodiversity arises, is maintained, and is affected by outside forces including climate change and direct human impacts.

Science for Decision-making

Ecosystem-based management provides many potential benefits, but also imposes new responsibilities on managers. The need to collect good information and to improve understanding is perhaps foremost among these new responsibilities. Despite considerable progress over the last century, the oceans remain one of the least explored and most poorly understood environments on the planet.

Greater knowledge can enable policy makers and managers to make science-based decisions at the national, regional, state, and local levels. Existing research and monitoring programs, which tend to be agency- and issue-centric, should be reoriented to become ecosystem-based. This will help resolve the current mismatch between the size and complexity of marine ecosystems and the many fragmented research and monitoring programs for coastal and ocean ecosystems.

In addition to the need for better understanding, the nation lacks effective mechanisms for incorporating scientific information into decision-making processes in a timely manner. As knowledge improves, it must be actively incorporated into policy through an adaptive process. To make this policy translation effective, local, state, regional, and national managers need an avenue to communicate their information needs and priorities.

Better coordination can facilitate more efficient use of existing funds. However, to significantly improve U.S. management of oceans and coasts and make ecosystem-based management a reality, the nation will need to commit to greater investments in ocean science, engineering, exploration, observations, infrastructure, and data management. Increased investments will help restore the pre-eminence of U.S. ocean capabilities, which has eroded since the end of the Cold War.

Although multiple use conflicts are common in coastal and ocean environments, efforts to understand the social, cultural, and economic dimensions of ocean issues have received surprisingly little support. Because of this, studies of humans and their behavior—so critical to virtually every ecosystem—deserve special emphasis.

Effective Ocean Governance

National ocean policy can only be implemented if an effective governance system is in place. Many of the guiding principles defined in this chapter speak directly to this need. An effective governance system will be predictable, efficient, and accountable. Laws, policies, and programs must be well coordinated and easily understood by regulated parties and the public. A comprehensive framework should be in place that defines the appropriate roles for all levels of government, the private sector, and citizens in managing ocean and coastal resources. Equally important, decision makers and the public should be accountable for decisions and actions that affect the ocean and its resources.

Participation by a broad sector of the public is essential to a successful ocean governance system. Facing an array of complex problems and competing desires, interested parties must reach agreements on what actions are needed, which are of greatest priority, and how to implement decisions once they are made. Public input is critical to this decision-making process so that all interests are fairly represented and support is built from the ground up. Without a truly participatory form of ocean governance, dispute and litigation are inevitable. At the same time, clear roles, jurisdictions, and authorities must be delineated to avoid gridlock and allow progress.

Today, no federal entity has the mission to evaluate the vast array of federal actions affecting ocean and coastal resources and to advocate for more effective approaches, prioritized investment, improved agency coordination, and program consolidation where needed. Nor is there a coherent national policy for ocean management that guides the missions of various federal agencies. A more unified federal voice is also needed in discussing policy options with the many nonfederal stakeholders.

Not since the Stratton Commission in the 1960s has an opportunity such as this existed. To propose major modifications in ocean governance that will create positive change for today and for future generations is one of the top priorities of this Commission.

Public Education

Education has provided the skilled and knowledgeable workforce that made America a world leader in technology, productivity, prosperity, and security. However, rampant illiteracy about science, mathematics, and the environment now threaten the future of America, its people, and the oceans on which we rely.

Testing results suggest that, after getting off to a good start in elementary school, by the time U.S. students graduate from high school their achievement in math and science falls well below the international average.[3] Ocean-related topics offer an effective tool to keep students interested in science, increase their awareness of the natural world, and boost their academic achievement in many areas. In addition, the links between the marine environment and human experience make the oceans a powerful vehicle for teaching history, culture, economics, and other social sciences. Yet teachers receive little guidance on how they might use exciting ocean subjects to engage students, while adhering to the national and state science and other education standards that prescribe their curricula.

A 1999 study indicated that just 32 percent of the nation's adults grasp simple environmental concepts, and even fewer understand more complex issues, such as ecosystem decline, loss of biodiversity, or watershed degradation.[4] It is not generally understood that nonpoint source pollution threatens the health of our coastal waters, or that mercury in fish comes from human activities via the atmosphere. Few people understand the tangible value of the ocean to the nation or that their own actions can have an impact on that resource. From excess applications of fertilizers, pesticides, and herbicides on lawns, to the trash washed off city streets into rivers and coastal waters, ordinary activities can contribute significantly to the degradation of the marine environment. Instilling a stewardship ethic in the American public is an important element of a national ocean policy. Without an acknowledgement of the impacts associated with ordinary behavior and a willingness to take the necessary action—which may incur additional costs—achieving a collective commitment to more responsible lifestyles and new policies will be difficult.

Excellent lifelong education in marine affairs and sciences is essential to raising public awareness of the close connection between the oceans and humans, including our history and culture. This awareness will result in better public understanding of the connections among the ocean, land, and atmosphere, the potential benefits and costs inherent in resource use, and the roles of government and citizens as ocean stewards.

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[1] Sherman, K., and L. Alexander, eds. *Variability and Management of Large Marine Ecosystems*. AAAS Selected Symposium 99. Boulder, CO: Westview Press, 1986.

[2] Norse, E., ed. Global Marine Biological Diversity: A Strategy for Building Conservation into Decision Making. Washington, DC: Island Press: 1993.

[3] Calsyn, C., P. Gonzales, and M. Frase. *Highlights from TIMSS* [Third International Mathematics and Science Study]. Washington, DC: National Center for Education Statistics, 1999.

[4] National Environmental Education & Training Foundation [NEETF]. *1999 National Report Card: Environmental Readiness for the 21st Century*. Washington, DC: NEETF/Roper Starch Worldwide, 1999.

Primer on Ocean Jurisdictions:

Drawing Lines in the Water

Although invisible to the naked eye, governments have carved the world's oceans into many zones, based on both international and domestic laws. These zones are often complex, with overlapping legal authorities and agency responsibilities. Internationally, the closer one gets to the shore, the more authority a coastal nation has. Similarly, for domestic purposes, the closer one gets to the shore, the more control an individual U.S. state has.

This primer explains the ocean jurisdiction of the United States under international law, as well as the domestic distinction between federal and state waters (Figure P.1).

The Baseline (0 Miles)

For purposes of both international and domestic law, the boundary line dividing the land from the ocean is called the *baseline*. The baseline is determined according to principles described in the 1958 United Nations Convention on the Territorial Sea and the Contiguous Zone and the 1982 United Nations Convention on the Law of the Sea (LOS Convention), and is normally the low water line along the coast, as marked on charts officially recognized by the coastal nation. In the United States, the definition has been further refined based on federal court decisions; the U.S. baseline is the mean lower low water line along the coast, as shown on official U.S. nautical charts. The baseline is drawn across river mouths, the opening of bays, and along the outer points of complex coastlines. Water bodies inland of the baseline—such as bays, estuaries, rivers, and lakes—are considered "internal waters" subject to national sovereignty.

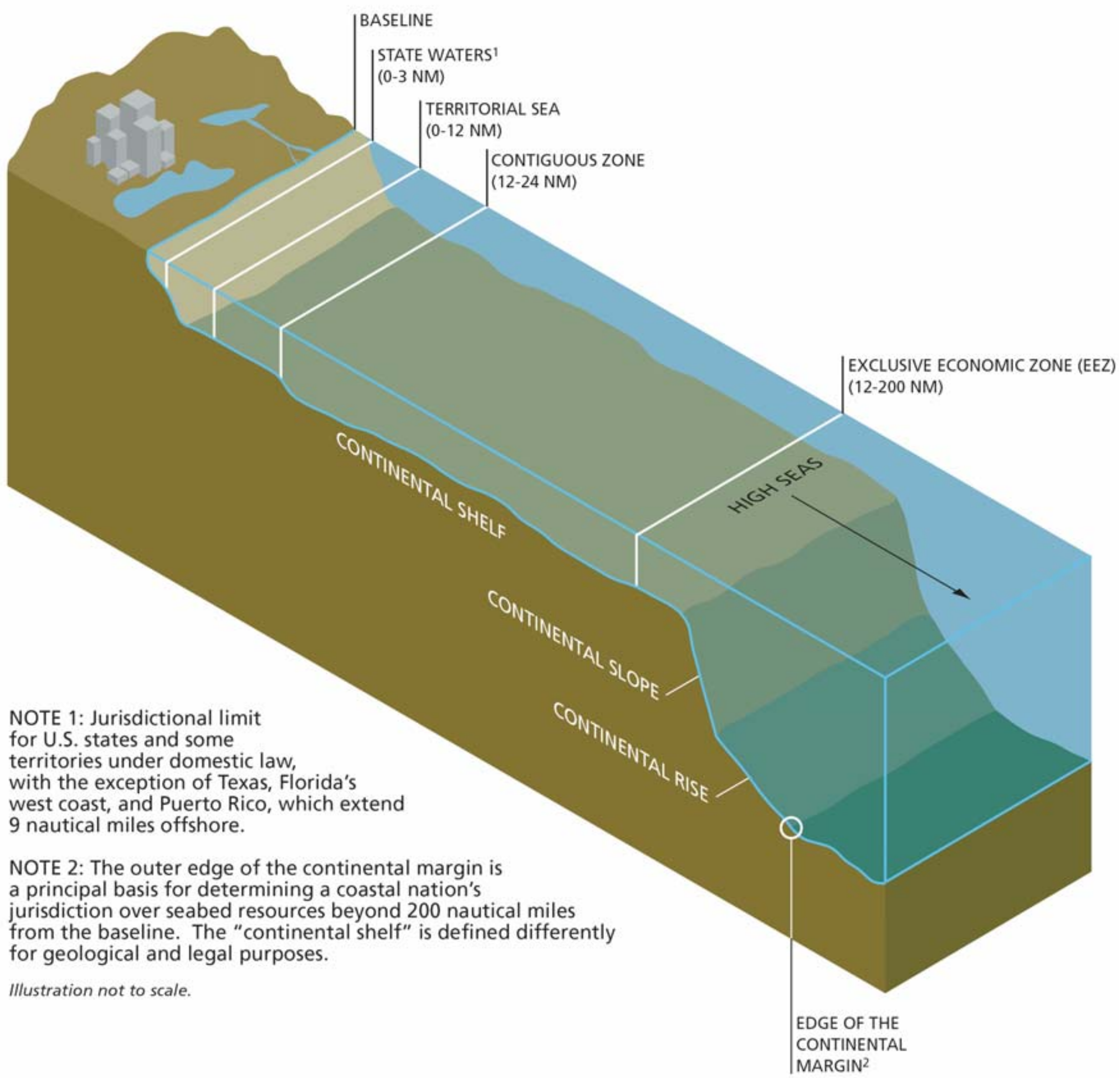
State Seaward Boundaries in the United States

(0 to 3 Nautical Miles; 0 to 9 Nautical Miles for Texas, Florida's Gulf Coast and Puerto Rico)

In the 1940s, several states claimed jurisdiction over mineral and other resources off their coasts. This was overturned in 1947 when the Supreme Court determined that states had no title to, or property interest in, these resources. In response, the Submerged Lands Act was enacted in 1953 giving coastal states jurisdiction over a region extending 3 nautical miles seaward from the baseline, commonly referred to as *state waters*. For historical reasons, Texas and the Gulf Coast of Florida are an exception, with state waters extending to 9 nautical miles offshore. (Note: A nautical mile is approximately 6,076 feet. All references hereafter to miles in this Primer are actually nautical miles.) Subsequent legislation granted the U.S. Virgin Islands, Guam, and American Samoa jurisdiction out to 3 miles, while Puerto Rico has a 9-mile jurisdictional boundary.

The federal government retains the power to regulate commerce, navigation, power generation, national defense, and international affairs throughout state waters. However, states are given the authority to manage, develop, and lease resources throughout the water column and on and under the seafloor. (States have similar authorities on the land side of the baseline, usually up to the mean high tide line, an area known as state tidelands.)

Figure P.1. Lines of U.S. Authority in Offshore Waters



Several jurisdictional zones exist off the coast of the United States for purposes of international and domestic law. Within these zones, the United States asserts varying degrees of authority over offshore activities, including living and nonliving resource management, shipping and maritime transportation, and national security. A nation's jurisdictional authority is greatest near the coast.

In general, states must exercise their authority for the benefit of the public, consistent with the public trust doctrine. Under this doctrine, which has evolved from ancient Roman law and English common law, governments have an obligation to protect the interests of the general public (as opposed to the narrow interests of specific users or any particular group) in tidelands and in the water column and submerged lands below navigable waters. Public interests have traditionally included navigation, fishing, and commerce. In recent times, the public has also looked to the government to protect their interests in recreation, environmental protection, research, and preservation of scenic beauty and cultural heritage.

The Territorial Sea (0 to 12 Nautical Miles)

Under international law, every coastal nation has sovereignty over the air space, water column, seabed, and subsoil of its *territorial sea*, subject to certain rights of passage for foreign vessels and, in more limited circumstances, foreign aircraft.

Prior to 1988, the United States claimed a territorial sea out to 3 miles. In that year, President Reagan proclaimed a 12-mile territorial sea for the United States, consistent with provisions in the LOS Convention. The proclamation extended the territorial sea only for purposes of international law, explicitly stating that there was no intention to alter domestic law.

Acknowledging Change: The Need to Update Federal Laws

Over the past twenty years, U.S. presidents have issued a series of proclamations changing the extent and nature of U.S. authority over the oceans. The changes, creating a territorial sea to 12 miles, a contiguous zone to 24 miles, and an exclusive economic zone to 200 miles, have not been comprehensively reflected in domestic laws. Many laws also use imprecise or inconsistent terms to refer to ocean areas, such as “navigable waters,” “coastal waters,” “ocean waters,” “territory and waters,” “waters of the United States,” and “waters subject to the jurisdiction of the United States.” These terms can mean different things in different statutes and sometimes are not defined at all.

Legal disputes have already occurred over the seaward extent of jurisdiction of the Endangered Species Act and the National Environmental Policy Act. The Clean Water Act and the Oil Pollution Act both refer to the 3-mile territorial sea. Inconsistencies or ambiguities in geographic definitions have caused problems in civil and criminal cases unrelated to natural resources, such as the regulation of offshore gambling. Congress has amended some laws regulating marine commerce to reflect the 12-mile U.S. territorial sea. However, there has been no systematic effort to review and update all ocean-related U.S. statutes and regulations.

The Contiguous Zone (12 to 24 Nautical Miles)

International law recognizes a *contiguous zone* outside the territorial sea of each coastal nation. Within its contiguous zone, a nation can assert limited authority, primarily related to customs, fiscal, immigration, and sanitary laws. In 1999, President Clinton proclaimed a U.S. contiguous zone from 12 to 24 miles offshore enhancing the U.S. Coast Guard’s authority to take enforcement actions against foreign flag vessels throughout this larger area.

The Exclusive Economic Zone (12 to 200 Nautical Miles)

The LOS Convention allows each coastal nation to establish an *exclusive economic zone* (EEZ) adjacent to its territorial sea, extending a maximum of 200 miles seaward from the baseline. Within its EEZ, the coastal nation has sovereign rights for the purpose of exploring, exploiting, conserving, and managing living and nonliving resources, whether found in ocean waters, the seabed, or subsoil. It also has jurisdiction over artificial islands or other structures with economic purposes.

The U.S. EEZ occupies the area between 12 miles (the seaward limit of the territorial sea) and 200 miles offshore for international purposes. Consistent with international law and traditional high-seas freedoms, the U.S. does not generally assert control over surface or submarine vessel transit, aircraft overflight, or the laying of cables and pipelines on the ocean floor. The United States does not assert jurisdiction over marine scientific research in the U.S. EEZ, although the LOS Convention would allow it.

THE CONTINENTAL SHELF (12 to 200 Nautical Miles or Outer Edge of Continental Margin)

The legal concept of the continental shelf has evolved over the last sixty years. A 1945 proclamation by President Truman first asserted a U.S. claim to resources on its continental shelf. This proclamation set a precedent for other coastal nations to assert similar claims over resources far from their shores. The need to establish greater uniformity was one of the driving forces behind the 1958 United Nations Convention on the Continental Shelf. However, the 1958 Convention showed limited vision, defining the continental shelf based on a nation's ability to recover resources from the seabed. As technological capabilities improved, uncertainty began anew about the seaward boundary of a nation's exclusive rights to continental shelf resources.

The LOS Convention generally defines the *continental shelf* for purposes of international law as the seafloor and subsoil that extend beyond the territorial sea throughout the natural prolongation of a coastal nation's land mass to the outer edge of the continental margin or to 200 miles from the baseline if the continental margin does not extend that far. The legal definition of the continental shelf thus overlaps geographically with the EEZ.

Where a coastal nation can demonstrate that its continental margin extends beyond 200 miles, the LOS Convention has a complex process for asserting such claims internationally. The U.S. continental margin extends beyond 200 miles in numerous regions, including the Atlantic Coast, the Gulf of Mexico, the Bering Sea, and the Arctic Ocean. However, because the United States is not a party to the LOS Convention, it can not assert its claims through the LOS mechanism (see Chapter 29).

THE HIGH SEAS (Areas Beyond National Jurisdictions)

International law has long considered areas of the ocean beyond national jurisdiction to be the *high seas*. On the high seas, all nations have certain traditional freedoms, including the freedom of surface and submerged navigation, the freedom to fly over the water, harvest fish, lay submarine cables and pipelines, conduct scientific research, and construct artificial islands and certain other installations. These freedoms are subject to certain qualifications, such as the duty to conserve living resources and to cooperate with other nations toward this end. In addition, a nation exercising its high seas freedoms must give due regard to the interests of other nations.

Originally defined as the area beyond the territorial seas of coastal nations, today the high seas are defined by the LOS Convention as the area seaward of the EEZs of coastal nations. Sixty percent of the world's oceans remain in this zone, where the traditional freedom of the seas still prevails. Even on the high seas, the United States and other coastal nations have some limited ability to exercise governmental authority. For example, U.S. citizens on the high seas remain subject to U.S. law, as do people on U.S.-flagged vessels and aircraft.

Part II
Blueprint for Change: A New National Ocean Policy Framework

CHAPTER 4:
ENHANCING OCEAN LEADERSHIP AND COORDINATION

More than thirty years have passed since the Stratton Commission issued its influential report. The time has come to again consider significant improvements to the nation's ocean and coastal governance system—improvements that build upon the Stratton Commission's approach, while acknowledging societal and environmental changes and taking advantage of scientific and technological advances. The U.S. Commission on Ocean Policy believes that an effective, integrated national ocean policy can be achieved through implementation of a new National Ocean Policy Framework. Each of the chapters in Part II focuses on one component of this framework.

The components of the new National Ocean Policy Framework are:

National Coordination and Leadership. *Chapter 4 describes the establishment, within the Executive Office of the President, of a National Ocean Council to coordinate and provide high-level attention to ocean policy. The Council would be chaired by an Assistant to the President, with nonfederal input from a Presidential Council of Advisors on Ocean Policy.*

A Regional Approach. *Chapter 5 focuses on the value of regional leadership and coordination and promotes the voluntary creation of regional ocean councils. These councils, established at the regional level with support from the National Ocean Council, would enhance the ability of federal, state, territorial, tribal, and local governments to respond to issues on a regional basis.*

Improved Governance of Offshore Waters. *Chapter 6 discusses the need to establish a coordinated offshore management regime for federal waters to avoid and minimize conflicts among ocean users, safeguard human and marine health, and manage the ocean for the maximum long-term benefit of the nation.*

A Strengthened and Streamlined Federal Agency Structure. *Chapter 7 proposes strengthening, and eventually reorganizing, the federal agency structure for ocean and coastal issues. As the nation's civilian ocean agency, the National Oceanic and Atmospheric Administration (NOAA) should be strengthened and reconfigured to improve the agency's ability to carry out its responsibilities. Subsequently, and where necessary and appropriate, related ocean and coastal programs in other agencies should be consolidated. In the long term, more dramatic changes to the federal agency structure are needed that acknowledge the inextricable connections among the sea, land, and air and all of Earth's living creatures.*

MAKING IMPROVEMENTS AT THE NATIONAL LEVEL

The previous chapters have illustrated many of the compelling reasons for addressing ocean and coastal issues in a new and improved fashion. There is a growing consensus about a number of ocean-related facts:

- the United States controls extensive resources in ocean and coastal areas that serve a wide range of national needs and are held in public trust.
- there are enormous opportunities for ocean science and technology to uncover new sources of energy, food, and drugs, and increase general understanding about the planet.
- serious risks to living marine resources exist, and degraded ocean environments need to be returned to productivity.
- national security requires greater awareness, knowledge, and observation of ocean and coastal areas.
- marine transportation needs to be enhanced to adequately handle growing demands from commerce and recreation.
- improved understanding of the factors influencing global climate change is needed, along with ideas for mitigating any adverse impacts.

Government agencies work on these and many other problems; however, a lack of communication and coordination continues to inhibit effective action.

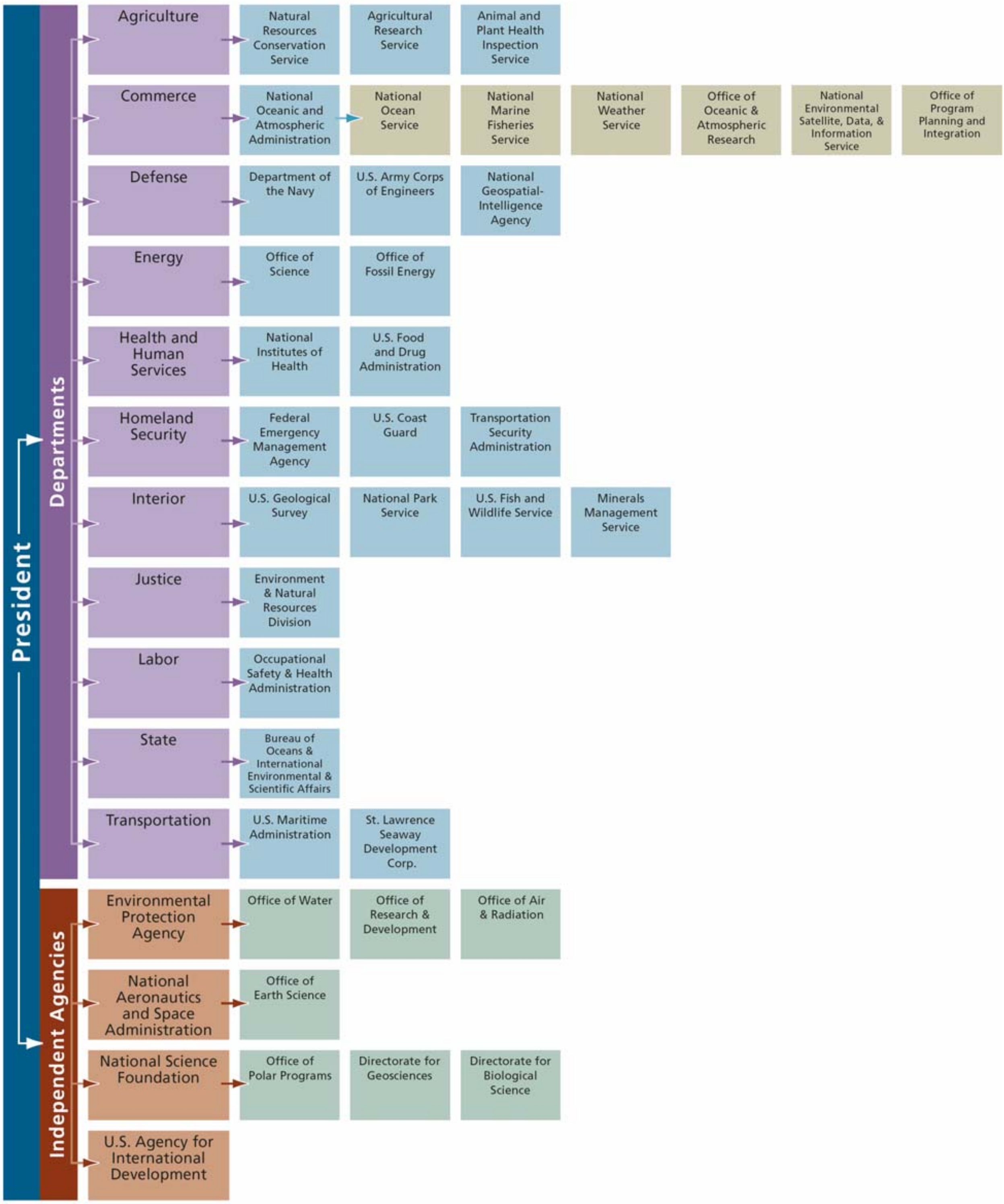
"Ocean issues" include virtually every aspect of the government's duties, from promoting international commerce to protecting the environment, and from guarding national security to facilitating tourism and recreation. More than half of the fifteen existing cabinet-level departments, plus several independent agencies, play important roles in the development of ocean and coastal policy (Figure 4.1). Many individual programs within these departments and agencies administer specific initiatives that address varying, and sometimes overlapping, ocean and coastal issues. A few additional departments have a more limited role in ocean policy, usually through a single division, such as the U.S. Department of Justice's Environment and Natural Resources Division.

A first step in enhancing the management of oceans and coasts, and a central part of the new National Ocean Policy Framework, is improving coordination among these many federal programs. A 1997 report by the National Research Council highlighted the need to harmonize ocean activities at the highest levels of government, with the objective of allowing federal agencies and the President to develop and carry out decisions within their authority.[1] The 2003 report of the Pew Oceans Commission, a privately funded initiative, also recognized the need to coordinate federal agency activities and address interagency disputes.[2]

Although a number of attempts have been made to achieve better coordination, none of them is adequate to cover the breadth of issues involved. Some coordinating mechanisms deal with particular topics, such as ocean research, coral reefs, or marine transportation. Other efforts are broader, but still fail to encompass the universe illustrated in Figure 4.1.

Within the Executive Office of the President, three entities have specific responsibilities that involve, to some extent, oceans. The Office of Science and Technology Policy supports the National Science and Technology Council in addressing government-wide science and technology issues. Within this structure, a Joint Subcommittee on Oceans was recently established to coordinate national ocean science and technology policy. The Council on Environmental Quality (CEQ) coordinates broad federal environmental efforts, oversees implementation of the National Environmental Policy Act, and serves as the principal environmental policy advisor to the President. Finally, the National Security Council's Global Environment Policy Coordinating Committee includes a subcommittee to address international ocean issues.

Figure 4.1. Ocean Activities are Conducted by Many Federal Agencies and Departments



The agencies and departments depicted have varying ocean and coastal responsibilities. The number and breadth of organizations demonstrate that—at a minimum—coordination is essential to effectively manage the nation's oceans and coasts.

While these efforts are helpful in their designated areas of interest, they fall far short of a high-level interagency council with the ability to deal with all of the interconnected ocean and coastal challenges facing the nation, including not only science and technology, environmental, and international matters, but the many other economic, social, and technical issues specifically related to the management of marine resources. In effect, the whole of the oceans is greater than the sum of the marine-related parts of existing institutions with their different responsibilities.

In addition to the need for multi-issue coordination, the value and importance of the ocean to American society calls for greater visibility and leadership on ocean issues. Only the Executive Office of the President can move past traditional conflicts among departments and agencies, make recommendations for broad federal agency reorganization, and provide guidance on funding priorities. Thus the Executive Office of the President is the appropriate venue to provide high-level attention and coordination for an integrated national ocean policy.

Although legislative action will be needed to codify the establishment of an ocean leadership body and ensure a national commitment to and long-term stability for ocean issues, immediate presidential action can facilitate an early start to the process.

Recommendation 4-1. Congress should establish a National Ocean Council and a nonfederal Presidential Council of Advisors on Ocean Policy within the Executive Office of the President to provide enhanced federal leadership and coordination for the ocean and coasts. While Congress works to establish these components in law, the President should begin immediately to implement an integrated national ocean policy by establishing the National Ocean Council and Presidential Council of Advisors on Ocean Policy through an Executive Order, and by appointing an Assistant to the President to chair the Council.

These recommendations are in line with developing international trends. The United States was a leader at the 2002 World Summit on Sustainable Development, which reiterated support for the principles developed at the 1992 Earth Summit in Rio de Janeiro, including a call for better coordination of environmental policy at the national level.[3] Several nations, including Australia, Brazil, Canada, Korea, and the Netherlands, have initiated strong national-level coordination on ocean and coastal policy.

National Ocean Council

There is important historical precedent for a body such as the National Ocean Council. The Marine Science, Engineering and Resources Council, chaired by the Vice President, was established in 1966 by the same statute that created the Stratton Commission. That council was disbanded in the early 1970s after the National Oceanic and Atmospheric Administration (NOAA) was established. Since then, no interagency body has existed to coordinate multi-agency implementation of an integrated national ocean policy.

The National Ocean Council would oversee all existing and new ocean- and coastal-related interagency mechanisms and coordination efforts. The Council would not have operational duties; rather, it would have responsibility for planning and coordinating, with support from a small staff and committees created to carry out specific functions.

Recommendation 4-2. The National Ocean Council (NOC) should provide high-level attention to ocean and coastal issues, develop and guide the implementation of appropriate national policies, and coordinate the many federal departments and agencies with ocean and coastal responsibilities.

The NOC should be:

- *chaired by an Assistant to the President.*
- *composed of cabinet secretaries of departments and directors of independent agencies with relevant ocean- and coastal-related responsibilities. Heads of other relevant executive departments, agencies, commissions, quasi-official agencies and senior White House officials should be invited to attend meetings of the NOC when appropriate.*

The NOC should carry out the following functions:

- *develop broad principles (based on those outlined in Chapter 3) and national goals for governance of the nation's oceans and coasts, and periodically review and revise these goals.*
- *make recommendations to the President on developing and carrying out national ocean policy, including domestic implementation of international ocean agreements.*
- *coordinate and integrate activities of ocean-related federal agencies and provide incentives for meeting national goals.*
- *identify statutory and regulatory redundancies or omissions and develop strategies to resolve conflicts, fill gaps, and address new and emerging ocean issues for national and regional benefits.*
- *guide the effective use of science in ocean policy and ensure the availability of data and information for decision-making at national and regional levels.*
- *develop and support partnerships among government agencies and nongovernmental organizations, the private sector, academia, and the public.*
- *expand education and outreach efforts by federal ocean and coastal agencies.*
- *work with a broad range of nonfederal stakeholders, governmental and nongovernmental, to develop a broad, flexible, and voluntary process for the establishment of regional ocean councils to help advance regional approaches.*
- *periodically assess the state of the nation's oceans and coasts to measure the achievement of national ocean goals.*

While the nation has made great strides in understanding the connections among the ocean, the atmosphere, the Earth, and the rest of the living world, it has been less successful in applying this knowledge to the management of ocean and coastal resources. New ocean and coastal policies should avoid the common practice of managing one activity or one part of an ecosystem without considering the impacts on and influences of other parts, including its human inhabitants. Rather, ocean policies should promote an ecosystem-based management approach, placing human interests and activities squarely within the context of the larger environment.

Moving toward such an approach requires several steps: assessing the ecosystem, including human needs; minimizing any threats and promoting opportunities; monitoring the ecosystem to evaluate progress; and revising management measures as appropriate. As part of the move toward an ecosystem-based management approach, a precautionary approach (described in Chapter 3) should be incorporated into decision-making processes and adopted by the National Ocean Council in developing national standards for ecosystem-based management.

Recommendation 4-3. The National Ocean Council (NOC) should adopt the principle of ecosystem-based management and assist federal agencies in moving toward an ecosystem-based management approach.

As part of this effort, the NOC should:

- *coordinate the development of procedures for the practical application of the precautionary approach and adaptive management.*
- *ensure that all resource agencies incorporate preservation of marine biodiversity in their management programs and all research agencies support further study of biodiversity.*

Assistant to the President

One role of the National Ocean Council is to resolve policy disputes and reach consensus among federal departments and agencies. To achieve this, the Council will need to be chaired by a high-level presidential appointee who is not part of any department or agency represented on the Council.

Recommendation 4-4. An Assistant to the President should be assigned to provide leadership and support for national ocean and coastal policy.

The Assistant to the President should have the following responsibilities:

- *chair the NOC.*
- *co-chair the Presidential Council of Advisors on Ocean Policy.*
- *lead NOC efforts to coordinate federal agency actions related to oceans and coasts.*
- *make recommendations for federal agency reorganization as needed to improve ocean and coastal management.*
- *resolve interagency policy disputes on ocean and coastal issues.*
- *reach out to state, territorial, tribal, and local stakeholders and promote regional approaches to ocean and coastal management.*
- *consult with the Office of Management and Budget (OMB) director and NOC members to identify programs that contribute significantly to the national policy for oceans and coasts, advise OMB and the agencies on appropriate funding levels for ocean- and coastal-related activities, and prepare a biennial report as mandated by section 5 of the Oceans Act of 2000.*

Presidential Council of Advisors on Ocean Policy

In 1969, the Stratton Commission recommended establishment of a broadly representative, presidentially-appointed committee of nonfederal individuals to provide continuing advice in the development of a national marine program. In response, in 1971 Congress created the National Advisory Committee on Oceans and Atmosphere (NACOA). NACOA reported to the President and Congress, advised the Secretary of Commerce, and provided analyses, recommendations, annual reports, and special studies on virtually every aspect of ocean policy. NACOA ceased meeting in the late 1980s, due primarily to lack of political support. Nevertheless, the need it fulfilled is more imperative than ever. To adequately represent the full spectrum of national interests, the National Ocean Council and the Assistant to the President will need input from a variety of interested groups and individuals from outside the federal government.

Recommendation 4-5. A Presidential Council of Advisors on Ocean Policy, a formal structure for input from nonfederal individuals and organizations, should advise the President on ocean and coastal policy matters.

The Presidential Council of Advisors on Ocean Policy should be:

- *composed of a representative selection of individuals appointed by the President, to include governors of coastal states, other appropriate state, territorial, tribal and local government representatives, and individuals from the private sector, research and education communities, nongovernmental organizations, watershed organizations and other nonfederal bodies with ocean interests.*
- *comprised of members knowledgeable about and experienced in ocean and coastal issues.*
- *co-chaired by the chair of the National Ocean Council and a nonfederal member.*

Other Needed Elements

Office of Ocean Policy

Because the National Ocean Council will be responsible for planning and coordination rather than operational duties, and because its cabinet-level members are unlikely to meet more than a few times a year, the support of a small staff and committees will be required to carry out its functions and associated daily activities. It is important for strong links to be maintained among the National Ocean Council, its committees, other relevant entities in the Executive Office of the President, as well as among other ocean-related advisory councils and commissions. (All the elements of the proposed national ocean coordinating structure are illustrated in Figure 4.2.)

Recommendation 4-6. Congress should establish an Office of Ocean Policy to support the Assistant to the President, the National Ocean Council (NOC), and the Presidential Council of Advisors on Ocean Policy. To provide staff support immediately, the President should establish an Office of Ocean Policy through the Executive Order creating the NOC and the Presidential Council of Advisors on Ocean Policy.

The Office of Ocean Policy should be:

- *composed of a small staff that reports to the Assistant to the President.*
- *managed by an executive director responsible for daily staff activities.*

Committee on Ocean Science, Education, Technology, and Operations

A committee under the National Ocean Council will be needed to assume the functions of the current National Ocean Research Leadership Council (NORLC), plus additional responsibilities. The NORLC is an important existing attempt at government coordination in one area. It was established by Congress in 1997 as the decision-making body for the National Oceanographic Partnership Program (NOPP) in an effort to provide coordination and leadership of oceanographic research programs on the national level. In addition to the NORLC, NOPP includes a Program Office, an Ocean Research Advisory Panel, an Interagency Working Group, a Federal Oceanographic Facilities Committee, and an ocean observing office (Ocean.US).

NOPP has had difficulty fulfilling the original vision of the National Oceanographic Partnership Act, due largely to the NORLC's lack of authority to ensure active participation by federal agencies. By placing the NORLC under the National Ocean Council, renaming it as the Committee on Ocean Science, Education, Technology, and Operations (COSETO), and broadening its responsibilities to include coordination, planning, and oversight of operational programs and education activities in addition to research, it will become more visible and more effective.

Because the Office of Science and Technology Policy (OSTP) plays an important role in government-wide science and technology issues, it is logical for OSTP to work closely with the National Ocean Council on these issues. In particular, a strong connection between OSTP and COSETO will be essential for providing coordinated, high-level advice to the President. The tasks of the existing Joint Subcommittee on Oceans under the National Science and Technology Council, which focus on coordination of ocean science and technology issues in the executive branch, would be appropriately subsumed by COSETO.

Recommendation 4-7. Congress, working with the National Ocean Council (NOC), should amend the National Oceanographic Partnership Act to integrate ocean observing, operations, and education into its marine research mission. A strengthened and enhanced National Ocean Research Leadership Council (NORLC) should be redesignated as the Committee on Ocean Science, Education, Technology, and Operations (COSETO), under the oversight of the NOC.

In particular, amendments to the National Oceanographic Partnership Act should specify that the newly-named COSETO:

- *reports to the NOC.*
- *is chaired by the director of the Office of Science and Technology Policy to ensure appropriate links to government-wide science and technology policy and equity among participating federal agencies.*
- *includes in its mandate coordination and planning of federal marine facilities and operations, federal oversight of the Integrated Ocean Observing System, and coordination of ocean-related education efforts, in addition to its existing research responsibilities.*

- *includes existing NORLC members plus the director of the National Institute of Environmental Health Sciences at the National Institutes of Health, the assistant secretary for Natural Resources and Environment at the Department of Agriculture, and the undersecretary for science at the Smithsonian Institution.*
- *subsumes the current tasks of the National Science and Technology Council's Joint Subcommittee on Oceans.*
- *is supported by the Office of Ocean Policy.*

Committee on Ocean Resource Management

In addition to COSETO, the National Ocean Council will need an equivalent working committee, the Committee on Ocean Resource Management (CORM), to coordinate federal resource management decisions and policy. In general, interagency coordination ranges from simple exchanges of information on a voluntary ad hoc basis, to legally mandated coordination on specific issues such as climate, marine mammals, or habitat conservation.

Examples of formal coordination mechanisms on ocean issues include the Coral Reef Task Force, the Interagency Committee on the Marine Transportation System, the National Dredging Team, Coastal America, and many others. Other formal coordinating bodies address broader issues with important ocean components, such as the National Invasive Species Council and the Joint Subcommittee on Aquaculture. Many of these institutions are discussed in greater detail elsewhere in this report, and most merit continued support. Indeed, additional task forces may be required to address new and emerging uses, such as the coordination of activities in federal waters. However, no high-level, cross-cutting oversight of these many ocean and coastal issue-specific efforts currently exists, limiting the federal government's consideration of cumulative impacts, conflicting mandates, and an ecosystem-based management approach.

Because of the Council on Environmental Quality's role in environmental and resource management issues, this office, like the Office of Science and Technology Policy, should have a strong connection with the National Ocean Council.

Recommendation 4-8. The National Ocean Council (NOC) should establish a Committee on Ocean Resource Management to better integrate the resource management activities of ocean-related agencies. This committee should oversee and coordinate the work of existing ocean and coastal interagency groups and less formal efforts, recommend the creation of new topical task forces as needed, and coordinate with government-wide environmental and natural resource efforts that have important ocean components.

The Committee on Ocean Resource Management should:

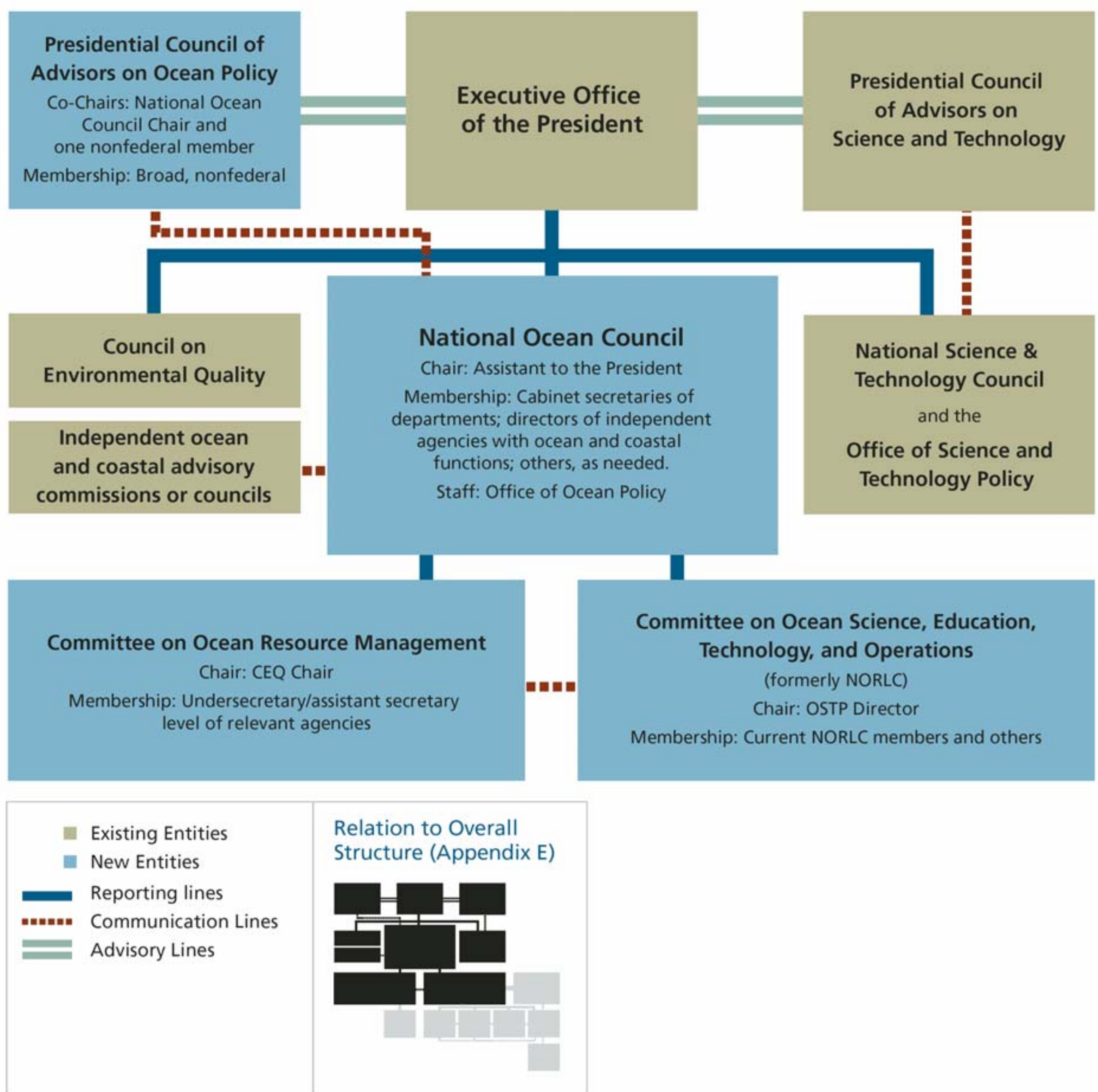
- *be chaired by the chair of the Council on Environmental Quality to ensure appropriate links to government-wide environmental policy and equity among participating federal agencies.*
- *include undersecretaries and assistant secretaries of departments and agencies that are members of the NOC.*
- *report to the NOC.*
- *be supported by the Office of Ocean Policy.*

Ocean-related Advisory Councils or Commissions

In addition to the interagency coordinating groups discussed above, a number of independent ocean-related councils and commissions have been established by law (Appendix D). Some are no longer operational, such as NACOA, while others maintain active roles, like the Marine Mammal Commission. Strong connections will be needed between all existing bodies and the National Ocean Council.

Recommendation 4-9. The National Ocean Council (NOC) should review all existing ocean-related councils and commissions and make recommendations about their ongoing utility, reporting structure, and connections with the NOC.

Figure 4.2. Proposed Structure for the Coordination of Federal Ocean Activities



Shown here are the institutional components that should be established in the Executive Office of the President (EOP) to improve federal leadership and coordination of the nation's oceans and coasts. This diagram also illustrates the organizational relationship between these new components and existing units in the EOP. The new and existing components located under the Committee on Ocean Science, Education, Technology, and Operations (shown in grey in the inset) are discussed in Chapters 8 and 25.

Making Improvements at the Regional Level

In addition to improving coordination at the national level, an important component of the new National Ocean Policy Framework is the strengthening of regional approaches that allow decision makers to address issues across jurisdictional lines. Further discussion about the need for a regional approach and the value of regional ocean councils is presented in Chapter 5.

Although regional ocean councils must be established in a flexible, voluntary, grassroots way by state and local participants, the National Ocean Council can help by providing a mechanism for participants to come together at the regional level. With its broad interests and high-level visibility, the National Ocean Council will be in a good position to facilitate the process of developing regional councils.

Recommendation 4-10. The National Ocean Council should work with Congress, the Presidential Council of Advisors on Ocean Policy, and state, territorial, tribal, and local leaders, including representatives from the private sector, nongovernmental organizations and academia, to develop a flexible and voluntary process for the creation of regional ocean councils.

The creation of regional ocean councils will undoubtedly be challenging. Regions vary greatly in their level of coordination, interest, and expertise. For this reason, efforts should be encouraged immediately in regions where readiness and support for a regional approach is already strong. The first councils can then serve as pilot projects, allowing those involved to learn what works in the region, building support to fully implement a regional ocean council, and paving the way for subsequent councils in other regions.

While the process of planning, organizing, and testing regional ocean councils is underway, federal agencies can begin to improve their own regional coordination and provide stronger institutional, technical, and financial support for regional issues. Currently, the activities of federal agencies with ocean and coastal responsibilities often overlap, conflict, or are inconsistent with one another at the regional and state levels. For example, navigation projects, highway development, and other federal infrastructure activities often conflict with environmental protection goals. Several federal agencies oversee habitat protection and restoration programs within the same region, but in isolation from one another. And federal agency regulations and permit requirements are typically applied on a project-by-project basis, without adequate consideration of the cumulative effect of these decisions on ocean and coastal ecosystems. The National Ocean Council's responsibility to examine ocean-related statutory and regulatory redundancies, resolve conflicts, and fill gaps will help clarify and rationalize regulatory guidance within the regions. But structural changes may also be needed.

Several federal agencies already divide their nationwide operations and management responsibilities along regional lines (Figure 4.3). For example, the U.S. Environmental Protection Agency (EPA) has ten regional offices throughout the nation, mapped along state lines. The seven regions of the U.S. Fish and Wildlife Service are also based on state lines, but differ from the states included in EPA's regions. NOAA's National Marine Fisheries Service has six regional offices. And the U.S. Army Corps of Engineers is organized into eight regions defined by the boundaries of watersheds, not state lines. The structures and functions of regional offices also differ among agencies, with some offices possessing more independence and authority than others. In some cases, regional offices have not had strong ties to their agencies' national management, and it is common for the regional office of one agency to operate in isolation from the corresponding regional offices of other agencies. The current structure hinders the ability of federal agencies with ocean- and coastal-related responsibilities to effectively interact on a regional basis with each other and with state, territorial, tribal, and local entities.

Figure 4.3. Alignment of Federal Regions is Essential for Communication

Shown above are the existing regional management areas for three federal agencies. Because these areas do not coincide, it is difficult for the agencies to coordinate and communicate over issues of common concern. Furthermore, this lack of coordination impedes their ability to effectively interact with regional, state, territorial, tribal, and local entities on a regional basis.

Recommendation 4-11. The President, through an Executive Order, should direct federal agencies with ocean- and coastal-related functions to immediately improve their regional coordination, as a precursor to reorganization around common regional boundaries and the eventual establishment of regional ocean councils.

As part of this process, federal agencies should:

- *collaborate with regional, state, territorial, tribal, and local governments and nongovernmental parties.*
- *identify major issues of concern in each region and, where possible, reconcile inconsistencies in agency mandates, regulations, practices, and funding that prevent these issues from being effectively addressed.*
- *identify opportunities for better coordination and communication among agencies, including the possible development of interagency protocols to guide regional decision-making.*
- *coordinate funding and grants to target major issues of concern in each region.*
- *maintain a strong connection with the National Ocean Council and suggest needed administrative or legislative changes to improve federal support of regional issues.*

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[1] National Research Council. *Striking a Balance: Improving Stewardship of Marine Areas*. Washington, DC: National Academy Press, 1997.

[2] Pew Oceans Commission. *America's Living Oceans: Charting a Course for Sea Change. A Report to the Nation—Recommendations for a New Ocean Policy*. Washington, DC, 2003.

[3] United Nations. *Report of the World Summit on Sustainable Development.* Johannesburg, South Africa, August 26–September 4, 2002. New York, NY, 2002.

Chapter 5: Advancing a Regional Approach

The nation's ocean and coastal resources are affected by the cumulative impacts of human activities that span cities, counties, states, and sometimes nations. To move toward an ecosystem-based management approach, federal, state, territorial, tribal, and local governments should be able to respond to ocean and coastal issues in a coordinated fashion across jurisdictional boundaries. The voluntary establishment of regional ocean councils, developed through a process supported by the National Ocean Council, would facilitate the development of regional goals and priorities, improve responses to regional issues, and enhance coordination of federal and state planning and management activities on a regional basis. In addition, to meet the information needs of decision makers, regional ocean information programs are needed to develop and disseminate regionally significant research and information.

Addressing Issues Crossing Jurisdictional Lines

Even though many pressing ocean and coastal issues take place on a regional scale, today's governance system is not designed to cross traditional political boundaries. Governments rarely consider impacts outside their immediate jurisdiction, although these borders seldom correspond with ecosystem boundaries. In addition, individual agency mandates are often too narrow in scope, sector-based, and poorly coordinated to address regional issues. Finally, broadly accepted regional goals—whether social, economic, or environmental—are not available to measure progress.

Despite these challenges, there are many instances where concern for the health of a particular ecosystem has motivated a wide range of participants to create new structures for addressing regional concerns. For example, the declining health of the Chesapeake Bay triggered a significant initiative by federal agencies, state and local governments, nongovernmental organizations, and other stakeholders to address the region's water quality and living resource problems. In the Pacific Northwest, a similar mix of governmental and nongovernmental entities have come together to reverse the decline in endangered salmon stocks. Efforts to address the growing hypoxic zone in the Gulf of Mexico have brought together several Gulf states, as well as states throughout the Mississippi River Basin. Likewise, U.S. island states and territories are collaborating to develop strategies to protect and preserve coral reef ecosystems. As these examples illustrate, regional efforts are usually initiated at the grassroots level in response to pressing, shared concerns.

However, there is a growing awareness that such regional approaches can benefit the health and productivity of all the nation's ocean and coastal regions. Focusing efforts within ecosystems, rather than political boundaries provides an opportunity for decision makers at all levels to coordinate their activities, reduce duplication of efforts, minimize conflicts, and maximize limited resources. It also promotes a sense of stewardship among government, private interests, and the public by encouraging a sense of connection with a specific area.

FACILITATING REGIONAL ORGANIZATION

Chapter 4 discussed the need for federal agencies to improve their coordination at both national and regional levels. Although this is important, the federal government is only one actor—and often not the most important actor—at regional, state, and local levels. As a result, one element of the U.S. Commission on Ocean Policy's proposed National Ocean Policy Framework is the development of improved mechanisms to encourage a wide range of participants (including state, territorial, tribal, and local leaders, and leaders from the private sector, nongovernmental organizations, and academia) to join forces in addressing issues of regional concern, realizing regional opportunities, and identifying regional goals. Such regional bodies would also provide a visible point of contact for federal agencies to communicate and coordinate with state and local decision makers.

A Flexible Process

Although regional processes should be initiated by those involved, rather than mandated at the federal level, broad national guidelines can facilitate the process and ensure consistency across regions. As discussed in Recommendation 4-10, the development of a flexible process to guide the voluntary creation of regional ocean councils will be a key function of the National Ocean Council, working with a wide range of other participants. A flexible approach will be necessary to meet the needs of the different regions, which vary dramatically in their environmental, political, social, and economic characteristics.

Recommendation 5-1. State, territorial, tribal, and local governments and nongovernmental participants should use the broad, flexible process developed through the National Ocean Council to begin the establishment of regional ocean councils.

The creation of regional ocean councils will be a complex and challenging endeavor. It should begin as soon as possible in those regions where readiness and support for a regional approach is already strong. The first councils can then serve as pilot projects, allowing everyone to learn what works and building support for broader implementation of regional ocean councils. Once established, regional ocean councils will most likely evolve, as participants identify the structure and functions that best suit their needs.

As the establishment of regional ocean councils gets underway, critical regional issues may arise that require immediate attention. In the absence of a regional ocean council, the National Ocean Council may convene ad hoc regional committees to make recommendations for addressing these issues. Once established, regional ocean councils will benefit from ongoing guidance, support, and interaction with the National Ocean Council.

Regional ocean councils, when voluntarily established under the process set forth by the National Ocean Council, may perform some or all of the following functions:

- designating ad hoc subcommittees to examine issues of regional concern.
- mediating and resolving disputes among entities within the region.
- developing more formal mechanisms for implementing decisions, such as interagency agreements, interstate compacts, or limited waivers of regulatory requirements.
- monitoring and evaluating the state of the region and the effectiveness of management efforts.
- building public awareness about regional ocean and coastal issues.
- facilitating required government approvals or permitting processes that involve several federal, state, and local government agencies within the region.

Regional ocean councils are not intended to supplant the functions or authority of any existing regional entity, such as regional fishery management councils. Rather, they will complement and enhance the effectiveness of current initiatives and provide guidance and support for future ones. Regional ocean councils will help ensure that issue-specific initiatives (such as regional dredging teams) and subregional initiatives (such as the Chesapeake Bay Program, the Florida Everglades restoration effort, or the CALFED Bay-Delta program) are carried out in harmony with one another and in a way that achieves larger regional goals.

Regional ocean councils will also have a role in helping ensure that offshore activities are planned and managed in an ecosystem-based context. Regional ocean councils should provide input to Congress during development of a coordinated offshore management regime. In particular, the councils will be important for engaging stakeholders in the design and implementation of marine protected areas. (Management of offshore uses, including the role of marine protected areas, is discussed in greater detail in Chapter 6.) Regional ocean councils will need to work with upstream decision makers outside their region on issues such as nonpoint source pollution. And in certain regions, including the Great Lakes, New England, the Pacific Northwest, and U.S. island territories, regional ocean councils may also need to work closely with other nations.

Regional Boundaries

Regional ocean councils should encompass relatively large areas with similar ecosystem features. Membership should include the many entities that participate in the management of activities within these areas. At a minimum, the boundaries of each regional ocean council should encompass the area from the inland extent of coastal watersheds to the offshore boundary of the nation's exclusive economic zone. The boundaries of the Regional Fishery Management Councils (RFMCs) may be used as a starting point in the process of developing each council, although these regions may not always be suitable. For example, more than one regional ocean council may be necessary along the Pacific Coast where there is only one RFMC. A regional ocean council for the Great Lakes region is also desirable.

Enhancing Regional Research and Information

Decision makers at all levels need the best available science, information, tools, and technology on which to base ocean and coastal management decisions. However, research targeted at regional concerns, such as the origins and impacts of nonpoint source pollution or the practical application of ecosystem-based management, is severely limited. Furthermore, the data that do exist are rarely translated into products that will be useful to managers.

A 2002 National Research Council report concluded that there is insufficient support for regional research, due primarily to a mismatch between the size and complexity of marine ecosystems and the fragmented authority for coastal research.[1] New programs are needed to fill these gaps and provide support for regional management by federal agencies and by the state, territorial, tribal, and local participants in the regional ocean council process.

Recommendation 5-2. Congress should establish regional ocean information programs to improve coordination and set regional priorities for research, data collection, science-based information products, and outreach activities in support of improved ocean and coastal management. Program priorities should be carried out primarily through a grants process.

Regional ocean information programs:
- *should be developed immediately, independent from the voluntary and potentially more complicated process of establishing regional ocean councils.*
- *may be subsumed within the regional ocean council structure, where regional ocean councils are established.*

Functions of the Regional Ocean Information Programs

Research

The regional nature of ecosystem processes calls for improved regional-scale research programs. Regional phenomena such as the transport of nutrients, toxic chemicals, and pathogens through coastal watersheds, the cumulative impacts of development on coastal habitat and water quality, socioeconomic trends in coastal areas, and the potential for new beneficial uses are poorly understood, often due to institutional barriers in undertaking comprehensive research efforts. A report prepared by state-level coastal resource managers found that scientific information is required over spatial scales beyond state jurisdiction, at a level of effort beyond the ability of states to support, and over time scales longer than state governments generally act.[2] The regional ocean information programs will help fill the gaps in current research to increase the understanding of ocean and coastal ecosystems.

Data Collection and Observations

Substantial efforts have been focused on the design and implementation of a nationwide network of regional ocean observing systems. These regional ocean observing systems will form the backbone of the national Integrated Ocean Observing System (IOOS), which will provide routine and timely information about the ocean and coastal environments to multiple users. The regional ocean information programs should oversee operation of the regional ocean observing systems, ensuring that the design of these systems is based on the needs of user groups while adhering to national standards. Input from the users will be essential in determining which variables should be included as priorities in the development of the IOOS. See Chapter 26 for more information on the IOOS and on the role of regional ocean information programs in coordinating the development of the regional components of the IOOS.

A water quality monitoring network, discussed in Chapter 15, will also be linked to the IOOS to help produce assessments and forecasts of ocean and coastal conditions, as well as conditions farther up the watershed. Together, these observing systems will help determine cause-and-effect relationships between stressors and impacts, facilitate more informed ocean and coastal management decisions, and gauge the effectiveness of these decisions.

Information for Practical Applications

To be useful, data and scientific results must be presented in a manner that is easily understood and applied by decision makers. Such information products are currently developed by a number of entities including the National Oceanic and Atmospheric Administration's (NOAA's) Coastal Services Center, whose purpose is to bring information, services, and technology directly to coastal resource managers. Regional ocean information programs will help translate ongoing regional research and data collection into usable products through partnerships with experts in this area, including the NOAA Coastal Services Center and a proposed new joint NOAA–Navy information program discussed in Chapters 26 and 28.

Outreach and Education for Decision Makers

Notwithstanding the availability of research and data products, decision makers may need education and training to effectively use this information and take full advantage of technological innovations. Since its establishment in 1966, the National Sea Grant College Program has been at the forefront of partnering with academia, government, and the private sector in this type of outreach effort. Sea Grant's well-established extension and communications programs, familiar to many resource managers and others in coastal communities, should be the primary mechanisms for delivering and interpreting information products developed through the regional ocean information programs. Participation by other education and training programs, such as NOAA's Coastal Training Program, will also be important to accomplish the mission of the regional ocean information programs.

Regional Ecosystem Assessments

Assessments of the natural, cultural, and economic attributes of each region, including an inventory of the region's environmental resources and demographic characteristics, would be extremely valuable to decision makers. These assessments could also be used to establish baselines for ocean and coastal ecosystem health, allowing decision makers to analyze the impacts of human activities and management actions. The regional ocean information programs will be ideally suited to undertake such assessments by integrating existing assessments and inventories, identifying additional information needs, and sponsoring research and data collection efforts.

In addition to enhancing decision-making, regional ecosystem assessments would improve the process mandated under the National Environmental Policy Act (NEPA) which requires federal agencies to prepare Environmental Impact Statements (EISs) for proposed major activities. Currently, each agency must conduct an individual assessment of the state of the environment to determine the impact of a proposed activity or related set of activities. The development of a single, scientifically-based regional ecosystem assessment would reduce this duplication of effort and help ensure that every EIS is based on similar, comprehensive, and timely information about the region.

Assessments are also important to evaluate the cumulative impacts over time of many proposed activities. Although guidelines developed by the Council on Environmental Quality (the office responsible for overseeing NEPA implementation) require federal agencies to prepare cumulative impact evaluations for proposed activities, challenges in developing a consistent approach have made it difficult for federal agencies to meet this requirement. A comprehensive and periodically updated regional ecosystem assessment that analyzes the status of the affected region, establishes baselines of ocean and coastal ecosystem health, and describes existing and potential impacts from a range of human activities will enhance decision makers' ability to analyze cumulative impacts.

Recommendation 5-3. Each regional ocean information program, with guidance from the National Ocean Council, should coordinate the development of a regional ecosystem assessment, to be updated periodically.

Recommendation 5-4. The Council on Environmental Quality should revise its National Environmental Policy Act guidelines to require that environmental impact statements for proposed ocean- and coastal-related activities take into account any available regional ecosystem assessments developed under the oversight of the regional ocean information programs.

Administration of the Regional Ocean Information Programs

Oversight boards will be needed to administer the regional ocean information programs. Each regional board should be comprised of both information providers and users from federal agencies, states, nongovernmental organizations, academia, and private companies. Unlike the voluntary regional ocean councils, which will determine their own boundaries over time, fixed boundaries are needed upfront for the regional ocean information programs. The following regions indicate the spatial scale on which regional ocean information programs should be developed:

- *Alaska*
- *Insular Pacific* (Hawaii, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands)
- *Northwest* (Washington, Oregon, and California to north of Point Arena)
- *Central West Coast* (California from Point Arena to Point Conception)

- *Southern California* (California from Point Conception to the Mexican border)
- *Gulf of Mexico* (Texas, Louisiana, Mississippi, Alabama, and Florida's Gulf coast,)
- *Southeast* (Florida's Atlantic coast including the Florida Keys, Puerto Rico, the U.S. Virgin Islands, Georgia, South Carolina, and North Carolina to south of Cape Hatteras)
- *Mid-Atlantic Bight* (North Carolina from Cape Hatteras, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, and Massachusetts to south of Cape Cod)
- *Gulf of Maine* (Massachusetts from Cape Cod, New Hampshire, and Maine)
- *Great Lakes* (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin)

Each regional ocean information program should collaborate with other regions or nations as needed to investigate issues that transcend program boundaries. Representatives from all the regional programs should meet at least once a year to ensure that information is exchanged, regional observing systems share common design features and data protocols, and research results are widely disseminated.

Recommendation 5-5. Congress should establish regional boards to administer regional ocean information programs throughout the nation. Program priorities should be carried out primarily through a grants process.

Each regional board should:

- *be comprised of federal agency representatives, representatives from each state in the region, and a Sea Grant Director from at least one state in the region. Each board should also have territorial, tribal, local, and other stakeholder representation.*
- *develop a comprehensive plan for regional research, data collection, information product development, and outreach based on regional information needs and priorities, and submit the plan to the National Ocean Council for approval.*
- *solicit proposals to carry out elements of the approved regional plan, and distribute funds to government, academic, private, or other groups selected through an open and competitive process.*
- *oversee the regional ocean observing systems to fulfill the data collection requirements of regional plans while adhering to national Integrate Ocean Observing System requirements.*
- *ensure that product development, dissemination, and user feedback are integral components of the regional observing systems.*

Recommendation 5-6. The National Ocean Council (NOC) should ensure that adequate support is provided for the operation of regional ocean information programs.

Funding should come from these sources:

- *the Integrated Ocean Observing System (IOOS) budget should support the regional ocean observing systems. IOOS funds should be appropriated to the National Oceanic and Atmospheric Administration, with spending subject to approval by the NOC as discussed in Chapter 26. Because of their operational nature, regional ocean observing systems should receive long-term, multi-year funding to achieve stability.*
- *a comparable amount of support needed to carry out the other research and communication functions of the regional programs should come from coordinated contributions from federal agencies and new funds described in Chapter 30.*

[1] National Research Council. *Bridging Boundaries through Regional Marine Research*. Washington, DC: National Academy Press, 2002.
[2] Keeley, D., et al. "More Effectively Using Our Observing, Monitoring, Research, and Education Infrastructure." Paper prepared for the California and the World Ocean Conference, Santa Barbara, CA, October 2002.

CHAPTER 6:
COORDINATING MANAGEMENT IN FEDERAL WATERS

Federal waters provide vast opportunities to build the nation's economy, enhance our quality of life, and increase knowledge about the workings of nature. Converging economic, technological, demographic, and other factors make federal waters an increasingly attractive place for new enterprises seeking to tap the ocean's resources, as well as for the continuation and expansion of traditional uses. The challenge for policy makers will be to unlock the ocean's potential while minimizing conflicts among users, safeguarding human and marine health, and fulfilling the federal government's obligation to manage public resources for the maximum long-term benefit of the entire nation. While legal, policy, and institutional frameworks exist for managing some ocean uses, there remain increasingly unacceptable gaps. The nation needs a coordinated offshore management regime that encompasses traditional and emerging uses and is adaptable enough to incorporate uses not yet clearly foreseen.

MEETING GROWING NEEDS

An important task for the new National Ocean Policy Framework is to improve the ability of the federal government to manage the growing number of activities taking place or being proposed in federal waters. This area, which extends from 3 to 200 nautical miles offshore, contains an enormous diversity of resources, many of which are used or affected by human activities. Within federal waters, the United States has sovereign rights for the purpose of exploring, exploiting, conserving, and managing the living and nonliving natural resources of the seabed and subsoil and the surface and subsurface of the waters. The federal government also has jurisdiction over the establishment and use of artificial structures, islands, and installations that have economic purposes, and the protection and preservation of the ocean environment. Associated with these authorities is the federal government's responsibility to ensure that ocean activities are managed for the benefit of the public.

In decades past, nearshore areas held certain inherent advantages for human activities—the waters tend to be shallower, logistics simpler, and costs lower. Increasingly, however, these advantages are shrinking. Nearshore waters are now crowded with competing users whose ranks are steadily augmented by surging coastal populations. There is also considerable public opposition to certain activities when conducted close to shore, such as those that involve the use of heavy equipment or disrupt scenic views. In addition, technological advances and an evolving scientific understanding of the ocean have made activities in offshore areas more feasible and economical than in the past.

For these reasons, interest in the use of federal waters is growing and activities farther offshore are expected to multiply. In many instances, these activities are mutually compatible and can take place in the same approximate area without problems. But in other instances, uses conflict with and can disrupt one another. While later chapters discuss many specific offshore activities, including fisheries (Chapter 19), aquaculture (Chapter 22), bioprospecting (Chapter 23), development of offshore energy and mineral resources (Chapter

24), and others, the focus of this chapter is the overarching offshore management regime that will be needed to coordinate all these activities and more—an important part of moving toward an ecosystem-based management approach.

An offshore management regime should embody strong principles and robust coordination for all ocean uses while recognizing the particular needs and challenges associated with each individual use. It must be able to address the needs of the ecosystem—including human needs—by prioritizing uses, minimizing conflicts, protecting resources, and ensuring that uses are compatible. It should also strike a balance between long-term and short-term strategies. For example, a legislative remedy may be warranted to address immediate concerns about one ocean activity, but the legislation should leave room to incorporate the activity within a broader, developing regime.

Any new offshore management regime should be grounded in the principles set forth in this report. For example, the nation should not wait until technologies are fully developed or scientific information is complete to establish mechanisms for managing new ocean uses. Instead, policy makers should proceed judiciously and responsibly to prepare for new uses, and to establish proactive means for identifying and remedying any negative impacts. Creating a coherent and coordinated management regime will make it easier for governments at all levels to protect the public interest and for private interests to make informed decisions.

One of the biggest obstacles to improving management of offshore resources is inadequate scientific understanding of how ecosystems function and how to evaluate the cumulative impacts of activities over time. Regional ecosystem assessments, as recommended in Chapter 5, provide a vehicle to comprehensively and periodically analyze the status of an ocean region, establish baselines for ocean ecosystem health, and describe existing or potential impacts from human activities. These assessments, coupled with a strong commitment to furthering scientific understanding of ecosystems and their components, would dramatically enhance the effectiveness of offshore management.

Clarifying Offshore Responsibilities

Numerous federal agencies are involved in managing offshore activities. Some activities, such as fishing or offshore oil and gas development, are governed according to well-developed regulatory regimes established in accordance with specific legislative mandates. Other activities, such as offshore aquaculture, are subject to regulation by a number of federal agencies executing varying responsibilities, but are not addressed by any comprehensive federal law. For emerging ocean uses, such as wind energy development, authorities and responsibilities remain dispersed and unclear.

The array of agency responsibilities and lack of coordination result in confusion that can create roadblocks to public participation, discourage private investment, cause harmful delays, and generate unnecessary costs. This is particularly true for new uses, for which federal agency responsibilities are scattered and ill defined and the decision making process is unclear. Without an understandable, streamlined, and broadly accepted method for reviewing a proposed activity, reactive, ad hoc management approaches will continue, perpetuating uncertainty and raising questions about the comprehensiveness and legitimacy of decisions.

Recommendation 6–1. Congress, working with the National Ocean Council (NOC), should ensure that each current and foreseeable use of federal waters is administered by a lead federal agency. The lead agency should coordinate with other federal agencies with applicable authorities and ensure full consideration of the public interest. Pending congressional action, the National Ocean Council should designate interim lead agencies to coordinate research, assessment, and monitoring of new offshore activities.

Swimming through Hoops: Establishing an Offshore Aquaculture Facility

The growing interest in offshore aquaculture offers an excellent example of how confusing and overlapping agency responsibilities create difficulties. As more entrepreneurs pursue this enterprise, they find they must cross several bureaucratic hurdles at the federal and state levels, often with little guidance from the agencies on what is needed, from whom, and when.

At the federal level, at least five agencies must be consulted or grant permits before an aquaculture facility can proceed:

- The Rivers and Harbors Act authorizes the U.S. Army Corps of Engineers to require permits for any device attached to the seafloor that poses a threat to navigation.
- The U.S. Coast Guard is responsible for marking potential obstructions to safe navigation.
- The Clean Water Act authorizes the U.S. Environmental Protection Agency (EPA) to require a National Pollutant Discharge Elimination System permit for any facility that discharges a pollutant into U.S. navigable waters or exclusive economic zone (EEZ).
- Although the Magnuson–Stevens Fishery Conservation and Management Act may not have been intended as a mechanism for managing marine aquaculture, NOAA asserts that the harvest of aquaculture species falls under the Act. Therefore, the Regional Fishery Management Councils (RFMCs) may develop management measures for aquaculture in offshore waters and the National Marine Fisheries Service (NMFS) may regulate aquaculture harvest based on such RFMC recommendations. In addition, NMFS, under the Endangered Species Act, must review aquaculture applications for any potential impacts on endangered species or marine mammals.
- In certain circumstances, the U.S. Fish and Wildlife Service may also review aquaculture applications for their impacts on endangered species or marine mammals, or other activities under its jurisdiction.

At the state level, each jurisdiction has its own procedures, with no uniformity among states. In fact, continuity is sometimes lacking even within a single state—one applicant may start the process with the state environmental protection office, another may start with the state marine fisheries agency, and a third may start with the state agricultural office.

Each of the federal and state offices may require a separate application, although much of the information required is exactly the same. Rarely do these offices coordinate with each other, and the application may be stopped at any stage. A more coordinated and consistent regime is needed to provide greater protections for the ocean environment, as well as to lessen unnecessary bureaucratic burdens on applicants.

Establishing a Coordinated Offshore Management Regime

There are essentially two categories of ocean uses. Some activities are confined to a specific location, often requiring an offshore structure such as an oil rig, a wind turbine, or an aquaculture pen. Other activities, such as fishing or recreation, are more diffuse, taking place within broad, flexible areas. To begin moving toward an ecosystem-based management approach, the federal government should develop a better understanding of offshore areas and their resources, prioritize uses, and ensure that activities in a given area are compatible.

Where a proposed activity will occupy a certain space to the exclusion of other uses, it is the federal government's responsibility to determine where the activity can take place, by whom, in what manner, and for what length of time. But these decisions should not be made in isolation: the agency administering the siting of aquaculture facilities, for example, must be aware of actions taken by another agency permitting offshore power generation facilities. As the pressure for offshore uses grows, and before serious conflicts arise, coordination should be immediately improved among single-activity management programs that regulate location-dependent activities. The National Ocean Council should review all such single-purpose ocean programs that regulate offshore activities with the goal of determining how such programs may be better coordinated.

However, to truly move toward an ecosystem-based management approach, coordination of *all* offshore activities is necessary—including those that are not tied to a specific geographic location. The new offshore management regime will also need to make sure that disputes are resolved and decisions made through an open process accepted by all parties.

Building a coordinated offshore management regime will take time. It will not be easy. No regime for governing ocean activities will eliminate all conflict, given the complexity of the problems and the diverse perspectives of competing interests. However, the National Ocean Council, Presidential Council of Advisors on Ocean Policy, regional ocean councils, and other components of the National Ocean Policy Framework provide the basis for more coordinated, participatory management of ocean activities. It provides the opportunity—one perhaps long overdue—for a larger federal-regional-state-stakeholders dialogue among stakeholders at the federal, regional, and state levels on a more coordinated and planned approach to the uses of and activities in offshore areas.

A Fair Return for the Use of Offshore Resources

The management of public resources also generally encompasses issues of public compensation. Specifically, economists refer to the economic value derived from a natural resource as *resource rent*. In the ocean, a natural resource may be an area, a space, a living or a nonliving resource. When publicly-owned and made available to the private sector, fairness and efficiency argue for a return of some portion of the rent received from the use or development of that resource to the public. This principle has been clearly established on land, where the government collects rents from ranchers through grazing fees and from timber and mining companies through royalties. The government also collects revenues from outer Continental Shelf oil and natural gas operations in the form of bonuses and royalties. In keeping with this principle, the public should also receive some return when private entities are allowed to use ocean space and other resources.

Recommendation 6-2. Congress, working with the National Ocean Council and regional ocean councils, should establish a coordinated, ecosystem-based offshore management regime that sets forth guiding principles for the balanced coordination of all offshore uses. It should recognize the need, where appropriate, for single-purpose ocean governance structures that are comprehensive and fully integrated with and based on the principles of the new offshore management regime. The regime should also include a process for planning for new and emerging activities and a policy that a reasonable portion of the resource rent derived from such activities is returned to the public.

Employing Marine Protected Areas as a Management Tool

Marine protected areas are one type of management tool the federal government can employ for locations and resources in estuarine, nearshore, and offshore areas in need of protection. A broad umbrella term, marine protected areas are created for many different reasons, including conserving living marine resources and habitat, protecting endangered or threatened species, maintaining biological diversity, and preserving historically or culturally important submerged archeological resources. These areas have also been recognized for their scientific, recreational, and educational values.

Marine protected areas can vary from restricting all activities to limiting only some uses. Examples of activities that might be restricted include oil and gas exploration and production, dredging, dumping, certain types of vessel traffic, fishing, and placing structures on the seabed. Marine protected areas can be set aside permanently or temporarily and can be implemented either seasonally or year-round. Even within a marine protected area, a particular activity may be allowed in one part of the area but not in others. Marine protected areas can be established and managed by a variety of agencies at the federal, state, territorial, tribal, and local levels, pursuant to a number of authorities.

Federal Efforts

The National Oceanic and Atmospheric Administration (NOAA) is authorized to develop and implement marine protected areas through several programs. NOAA manages thirteen marine protected areas as part of its National Marine Sanctuaries Program, and administers the National Estuarine Research Reserve System, which is made up of a network of twenty-six protected estuarine areas. The agency also manages a variety of fishery zones and area closures to protect critical habitat for threatened or endangered species.

The Department of the Interior (DOI), through the National Park Service (NPS) and the U.S. Fish and Wildlife Service (USFWS), is also authorized to create and manage marine protected areas. NPS manages the National Park System, which includes national parks, monuments, and preserves in ocean areas, as well as ten areas designated as national seashores on the Atlantic, Gulf, and Pacific coasts, and four national lakeshores along the Great Lakes coastline. USFWS manages the National Wildlife Refuge System, which includes more than 500 wildlife refuges, many of which are located in ocean and coastal areas. USFWS also manages critical habitat for endangered and threatened species that fall under its statutory responsibilities.

In 2000, an Executive Order on Marine Protected Areas directed NOAA and DOI to establish a Marine Protected Area Center. The Center is charged with developing a framework for a national system of marine protected areas and providing federal, state, territorial, tribal, and local governments with information, tools, and strategies for effectively designing and managing such areas. The Marine Protected Area Center has made progress in improving coordination and working to establish a national system of marine protected areas; however, further consolidation of the many related federal programs may be needed. Simplifying the multiplicity of marine protected area management regimes can lessen confusion, foster stewardship, and enhance enforcement. (Federal marine protected area programs are summarized in Appendix D.)

The Role of Marine Protected Areas

Marine protected areas are important tools for ecosystem-based management, although they will not in and of themselves deliver long-term sustainable use of the oceans. Other pressing problems will continue to require attention, including resource use outside protected areas, point and nonpoint source pollution, and intensive coastal development. For this reason, marine protected areas are most effective when they are designed within the broader context of regional ecosystem planning and adaptive management, and when they are employed in conjunction with other management tools.

When a marine protected area is determined to be the best approach for addressing ecosystem goals in a particular area, its design must take a number of factors into consideration. These factors include local, state, regional, and national objectives, ecosystem characteristics and threats, competing uses within the targeted area, ecological and socioeconomic impacts, and the capacity for effective implementation and enforcement of the protected area. Marine protected areas must also be designed using the best available scientific information to ensure that their establishment is likely to meet the intended objectives. Monitoring, periodic assessment, and modification are also essential to ensure the continuing effectiveness of marine protected areas.

Although at times controversial, appropriately designed and implemented marine protected areas have proven useful. A 2001 report by the National Research Council concluded that marine protected areas can be effective in maintaining marine biological diversity and protecting habitats and have the potential to provide a flexible, spatially-based management framework for addressing multiple ecological and socioeconomic objectives.[1] The report stated that, in particular, closing certain areas to fishing—temporarily, seasonally, or permanently—can advance sustainable fisheries management and provide insurance against uncertainties in fisheries science. Nevertheless, design and implementation of marine protected areas, like any other marine resource management measure, must be considered in the context of broader planning and implementation of a coordinated regime.

Sunken Treasures: Preserving Historic Artifacts

A number of marine sanctuaries, national and state parks, and national historic monuments have been established to protect shipwrecks and other submerged cultural resources. At least 50,000 shipwrecks are scattered about the territorial waters and exclusive economic zone of the United States. Many hold considerable historic, archeological, recreational, and financial value.

Commercial salvors have used traditional admiralty law to justify their right to locate, recover, and remove objects of value from shipwrecks. However, many archeologists argue that historic shipwrecks and other submerged sites, as well as the material recovered from them, are part of the nation's collective heritage, and the sale of artifacts deprives the public of important historical, cultural, and educational assets. While laws are in place to address conflicts about ownership and management of submerged cultural resources, they have been implemented with only modest success. A coordinated offshore management regime needs to recognize the potential importance of some of these sites and should consider preserving them for future generations by establishing protected areas when necessary.

National Interests

It is appropriate for marine protected areas to be designed and implemented with strong input from the regional and local levels. However, because marine protected areas have the potential to affect issues of national concern, such as freedom of navigation, there will always be a need for national-level oversight. With its multiple use, ecosystem-based perspective, the National Ocean Council is the appropriate entity for overseeing the development of a uniform process to design and implement marine protected areas.

The design of marine protected areas should not unreasonably limit important national interests, such as international trade, national security, recreation, clean energy, economic development, and scientific research. For example, in most cases freedom of navigation through marine protected areas should not be restricted. However, where some infringement on such national interests is deemed essential to achieving the purposes of a marine protected area, restrictions should be based on sound science, with a plan for ongoing monitoring and modifications over time. The overall ecological and socioeconomic impacts of marine protected areas should also be evaluated at the national level.

Recommendation 6–3. The National Ocean Council should develop national goals and guidelines leading to a uniform process for the effective design and implementation of marine protected areas.

The process should include the following:

- *marine protected area designations that are based on the best available scientific information to ensure that an area is appropriate for its intended purpose.*
- *periodic assessment, monitoring, and modification to ensure continuing ecological and socioeconomic effectiveness of marine protected areas.*
- *design and implementation that consider issues of national importance, such as freedom of navigation, and are conducted in the context of a comprehensive offshore management regime.*

Regional and Local Stakeholders

Part of the controversy surrounding marine protected areas stems from the impacts their restrictions can have on stakeholders. While some stakeholders recognize the benefits of creating such areas, others vigorously oppose the limitations on otherwise legal ocean uses. When designing and implementing a marine protected area, it is important to engage all regional and local stakeholders to build support for the proposed protected area and to ensure compliance with any restrictions it may impose.

Because marine protected areas are used to accomplish a broad range of objectives and have different meanings for different people, it is imperative that each proposed area has clearly defined regional goals and objectives that are consistent with national goals and guidelines. Regional ocean councils, or other appropriate state and local entities, can provide a forum for applying the uniform process developed by the National Ocean Council to design and implement marine protected areas. They can also facilitate public discussion of the trade-offs inherent in their implementation. Well-designed scientific studies at the design and review stages can assist in the evaluation of the potential impacts of the marine protected area on communities.

Recommendation 6–4. Regional ocean councils, or other appropriate regional entities, should actively solicit stakeholder participation and lead the design and implementation of marine protected areas. The design and implementation should be conducted pursuant to the goals, guidelines, and uniform process developed by the National Ocean Council.

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[1] National Research Council. *Marine Protected Areas: Tools for Sustaining Ocean Ecosystems.* Washington, DC: National Academy Press, 2001.

Chapter 7:
Strengthening the Federal Agency Structure

Although improved coordination is a vital aspect of the new National Ocean Policy Framework, changes to the structure of some federal agencies will also be needed to enable effective implementation of national ocean policy. Immediate strengthening of the National Oceanic and Atmospheric Administration's (NOAA's) ability to carry out its many ocean- and coastal-related responsibilities is critical, to be followed by consolidation, where appropriate, of other agency ocean and coastal programs. Over the long term, more fundamental changes to the federal agency structure should be made to recognize the inextricable connections among the sea, the land, the atmosphere and all living creatures on Earth, including humans. Strengthening the federal agency structure through a phased approach—in combination with improving coordination through the National Ocean Council—will improve agency performance, reduce unnecessary overlap, and significantly enhance the long-term goal of addressing the nation's management of oceans, coasts, and other natural resources through an ecosystem-based management approach.

Reorganizing to Support an Ecosystem-based Management Approach

New knowledge about the functioning of ecosystems—and specifically about our ocean and coastal regions—supports the need for fundamental changes in the nation's approach to managing its resources. The benefits of improved coordination at national and regional levels were discussed in Chapters 4 through 6, and a number of recommendations made. But even excellent coordination does not preclude the need to consider reorganization—the new National Ocean Policy Framework contemplates both. The proliferation of federal agencies with some responsibility for ocean and coastal activities (illustrated in Chapter 4, Figure 4.1) strongly suggests that consolidation might improve government performance, reduce unnecessary overlaps, facilitate local, state, and regional interactions with the federal government, and begin to move the nation toward an ecosystem-based management approach.

Reviewing Previous Reorganization Proposals

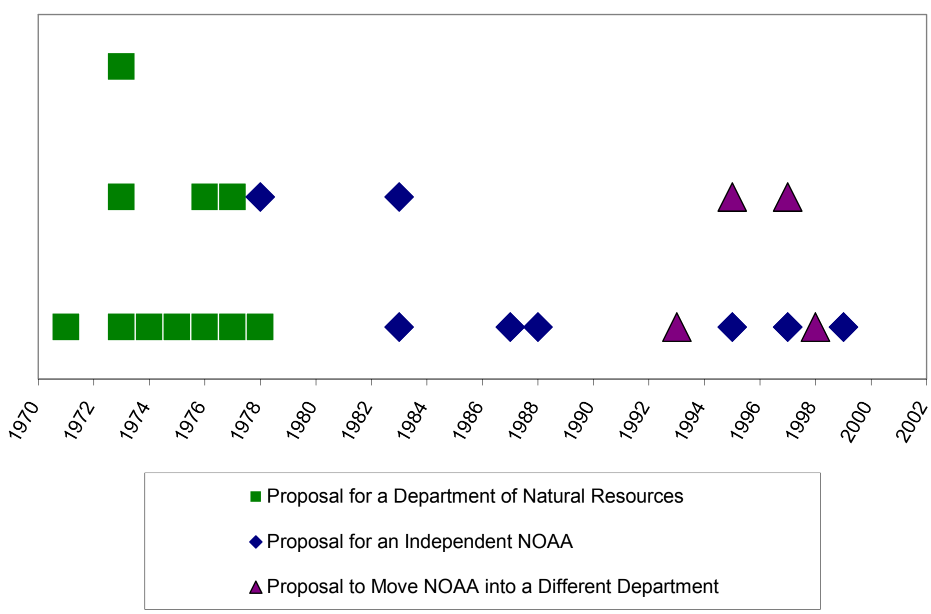
In 1969, the Stratton Commission called for the establishment of a major new independent agency to administer the nation's civil marine and atmospheric programs.[1] Around the same time, the President's Advisory Council on Executive Reorganization (known as the Ash Council) made recommendations for more effective management of all federal programs and agencies.

Based on the advice from these two groups, the Nixon administration planned to create an ocean and atmospheric agency and to place it under a new Department of Natural Resources, in which the Department of the Interior and several other agencies were identified as key elements. However, in 1970 the administration decided, largely for political reasons, to establish the National Oceanic and Atmospheric Administration (NOAA) as an agency within the U.S. Department of Commerce (DOC).

Since that time, members of Congress have introduced many reorganization proposals to improve federal management generally, or specifically as it affects oceans and coasts. Two presidential proposals addressed broad reorganization around natural resources, while a national advisory committee on oceans and coasts proposed specific recommendations to improve the federal agency structure in that area. Proposals in the 1970s called for putting NOAA within a broader Department of Natural Resources, while a mix of proposals during the 1980s and 1990s would have either established an independent NOAA or moved parts of the agency to a different department. In the end, largely because of the political complexity associated with any reorganization of executive branch agencies, none of the proposals to reorganize or relocate NOAA was adopted. (Brief summaries of past proposals are included at the end of this chapter and summarized in Figure 7.1.)

Despite past failures to reorganize ocean and coastal programs, the concept of combining federal programs with similar functions remains under active consideration. In its 2003 report, the National Commission on the Public Service (known as the Volcker Commission) concluded that the historical phenomenon of governmental expansion on an issue-by-issue basis has resulted in a "virtually unmanageable tangle of government activities" that negatively affects program performance. That commission emphasized the need to reorganize the federal government "into a limited number of mission-related executive departments."[2]

Figure 7.1. Proposals to Reorganize Federal Ocean Management



Since 1970, there have been over 20 congressional, two presidential, and a number of other proposals by federal advisory committees to consolidate the management of natural resources, including oceans, within the federal government. Most recently, proposals have focused on establishing NOAA as an independent agency, or moving it out of the Department of Commerce to a more compatible home.

The complexity of the current policy-making process, with its many political and jurisdictional components, compels a cautious, methodical, phased approach for moving toward a more ecosystem-based federal structure. The phases should include:

1. *Phase I—Immediate Action*: Solidify NOAA's role as the nation's lead civilian ocean agency through the enactment of a NOAA organic act that codifies the agency's establishment within the Department of Commerce, clarifies its mission, and strengthens execution of its functions.
2. *Phase II—Medium-term Action*: Consolidate selected ocean and coastal functions and programs from other agencies where such consolidation would eliminate unnecessary duplication, achieve more effective policy implementation, and not undermine the central mission of the other agencies.
3. *Phase III—Long-term Action*: Include oceans and coasts within a unified federal agency structure to manage all natural resources according to an ecosystem-based management approach.

Strengthening NOAA: Phase I

NOAA's mission is to understand and predict changes in the Earth's environment and to conserve and manage ocean and coastal resources to meet the nation's economic, social, and environmental needs. The agency's responsibilities have been spread across five line offices: the National Ocean Service; the National Marine Fisheries Service; the National Weather Service; the National Environmental Satellite, Data, and Information Service; and the Office of Oceanic and Atmospheric Research.

Since its creation, NOAA has made significant strides in weather prediction, navigational charting, marine operations and services on the ocean and along the coast, management and protection of living marine resources, satellite operations, processing and distribution of data, and development of innovative technologies and observing systems. These successes have occurred despite significant programmatic and functional overlaps, and frequent disagreements and disconnects among the current line offices. Recently, a sixth line office, the Office of Program Planning and Integration, was established to improve horizontal integration among NOAA line offices. Although this change will require time to take hold and show results, such initiatives constitute one of many steps required to strengthen NOAA's performance.

NOAA needs both to manage its current activities more effectively and, if some or all of the recommendations discussed in this report are implemented, to handle a number of new responsibilities. For example, Chapter 26 discusses significant improvements that will be needed at NOAA to enable its effective implementation of the Integrated Ocean Observing System (IOOS), including streamlined distribution of funds to other involved agencies, closer partnerships with industry and academia, and the ability to assume operational responsibilities for satellite Earth observing programs. A stronger, more effective, science-based and service-oriented ocean agency—one that contributes to better management of oceans and coasts through an ecosystem-based approach—is needed.

Improving Ocean and Coastal Management by Enhancing NOAA's Capacity

NOAA is currently responsible for a variety of ocean and coastal activities and this report contains many recommendations intended to increase the agency's responsibilities and strengthen its performance in the following areas:

- Ocean exploration.
- Implementation of the Integrated Ocean Observing System.
- Scientific planning and budgeting.
- Research support in a broad range of areas, including socioeconomics, oceans and human health, and monitoring.
- Infrastructure and technology development, including the transition from research to operations.
- Mapping and charting.
- Data and information management and communication.
- Formal and informal education for all ages.
- Domestic and international fishery management.
- Marine mammal and other marine species protection.
- Coral reef conservation.
- Sustainable aquaculture.
- Coastal and watershed management.
- Natural hazards planning and response.
- Habitat conservation and restoration.
- Coastal sediment management.
- Water pollution and water quality monitoring.
- Invasive species control.

NOAA's three primary functions can be categorized as follows: 1) assessment, prediction, and operations for ocean, coastal, and atmospheric environments; 2) marine resource and area management; and 3) scientific research and education. One of the critical objectives for a strengthened NOAA is improved interaction within and among these categories. The execution of NOAA's functions should complement and support each other. For example, resource management decisions should be based on the best available science, research efforts should be planned to support the agency's management missions, and all research—sea, land, and air—should be connected and coordinated. Changes of this nature will likely require adjustments to the internal operation of the agency, including possible additional changes to the current line office structure.

Recommendation 7–1. Congress should pass an organic act that codifies the establishment and missions of the National Oceanic and Atmospheric Administration (NOAA). The act should ensure that NOAA's structure is consistent with the principles of ecosystem-based management and with its primary functions of assessment, prediction, and operations; management; and research and education.

Specifically, NOAA's structure should support its role in:

- *assessment, prediction, and operations for ocean, coastal, and atmospheric environments, including mapping and charting, satellite-based and in situ data collection, implementation of the Integrated Ocean Observing System, broadly based data information systems, and weather services and products.*
- *management of ocean and coastal areas and living and nonliving marine resources, including fisheries, ocean and coastal areas, vulnerable species and habitats, and protection from pollution and invasive species.*

- *research and education on all aspects of marine resources, including a focus on the importance of research and development, the use of scientifically valid technical data throughout the agency, and with external partners and promotion of educational activities across the agency and with the public.*

NOAA's entire structure, leadership, and staff should be oriented to support the effective exercise of these functions. Beginning with a strengthened science program and a more service-oriented approach, NOAA should be organized not only to improve its efficiency, but also to promote inclusiveness and a commitment to meaningful partnerships with other agencies, states, the private sector, and the academic community. International responsibilities will also need visibility at the highest levels of the agency.

As the clear lead civilian ocean agency in the federal government, NOAA will require budget support commensurate with its important and varied responsibilities. NOAA's placement within DOC may be partly responsible for insufficient visibility, but it has definite budgetary implications. At this time, NOAA's budget is reviewed within the Office of Management and Budget's (OMB's) General Government Programs, along with other elements of DOC such as the Bureaus of Industry and Security, Economics and Statistics, and Economic Analysis, the Census Bureau, the International Trade Administration, and the Patent and Trademark Office. These programs all have fundamental characteristics and missions programmatically separate from NOAA's, requiring budget examiners with very different expertise and perspectives. NOAA's placement within OMB also precludes its ocean and atmospheric programs from being considered in an ecosystem-based context along with the other resource and science programs in the federal government.

Recommendation 7-2. The President should instruct the Office of Management and Budget (OMB) to review the National Oceanic and Atmospheric Administration budget within OMB's Natural Resources Programs, along with the budgets of the U.S. Departments of Agriculture, Energy, and the Interior, the U.S. Environmental Protection Agency, the National Science Foundation, the National Aeronautics and Space Administration, and the U.S. Army Corps of Engineers' Directorate of Civil Works.

Consolidating Ocean and Coastal Programs: Phase II

In addition to NOAA, many other agencies across the federal government administer ocean- and coastal-related programs. In fact, although NOAA encompasses the single largest aggregation of civilian ocean programs, other agencies, taken together, represent the majority of federal spending on ocean, coastal, and atmospheric issues. Thus, changes within NOAA address only one part of the federal agency structure for oceans and coasts. Other agencies with ocean-related activities must be strengthened in a similar manner.

Recommendations throughout this report are intended to strengthen the execution of programs in other federal agencies with ocean- and coastal-related responsibilities, including the U.S. Departments of Agriculture, Commerce, Defense, Energy, Health and Human Services, Homeland Security, Interior, Labor, State, and Transportation, and the U.S. Environmental Protection Agency (EPA), the National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF). The goal of moving toward an ecosystem-based management approach requires that all agencies consider how the central functions of assessment, prediction, and operations, resource management, and scientific research and education fit within their missions. The structure and coordination of these primary functions within each agency should assure they are complementary and support each other.

Federal Ocean and Coastal Activities in Agencies other than NOAA

The U.S. Department of the Interior's (DOI's) mission is to protect the nation's treasures for future generations, provide access to the nation's natural and cultural heritage, provide wise stewardship of energy and mineral resources, foster sound use of land and water resources, and conserve and protect fish and wildlife. Several agencies within DOI have ocean and coastal functions including the U.S. Geological Survey (USGS), the National Park Service (NPS), the U.S. Fish and Wildlife Service (USFWS), and the Minerals Management Service (MMS). USGS provides scientific information to describe and understand the Earth, minimize loss of life and property from natural disasters, and manage water, biological, energy, and mineral resources. The goal of NPS is to conserve the scenery, the natural and historic objects and the wildlife therein, and to provide for the enjoyment of these resources in a manner that will leave them unimpaired for future generations. Many units within the National Park System are located in coastal areas. The USFWS mission is to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. MMS assesses the nature, extent, recoverability, and value of leasable minerals on the outer Continental Shelf. It oversees the development and efficient recovery of mineral resources and promotes the use of safe offshore operational technologies.

The mission of the U.S. Environmental Protection Agency (EPA) is to protect human health and to safeguard the natural environment—air, water, and land—upon which life depends. Within the EPA, the Office of Water includes the Office of Wetlands, Oceans, and Watersheds, which addresses wetlands protection, protection of ocean and coastal environments including watersheds and estuaries, management of dredged material, and water quality monitoring.

The National Aeronautics and Space Administration's Earth Science Enterprise studies the Earth from space through environmental research programs and observing systems to meet the needs of the nation's scientific communities.

The U.S. Army Corps of Engineers' Directorate of Civil Works, located in the U.S. Department of Defense, administers flood control and shore protection programs, environmental restoration programs, and the regulation of U.S. waters and wetlands.

The U.S. Coast Guard, a multi-mission agency recently transferred from the U.S. Department of Transportation to the new U.S. Department of Homeland Security, is the principal federal marine enforcement agency for environmental and natural resource regulations in U.S. ocean and coastal waters, and regulates vessel and port safety, security, and environmental protection.

The U.S. Navy contributes significant resources to ocean science activities. Through the Office of Naval Research and the Naval Meteorological and Oceanography Command, the Navy has been instrumental in a number of areas since long before the creation of NOAA. Some of these areas include global ocean and seafloor data collection, archival, modeling, data fusion, and product generation, as well as a wide array of ocean research and technology, diving and salvage technology, deep submergence, ocean engineering and construction, and medical research.

Other agencies in the Departments of Defense and Homeland Security also carry out activities with significant ocean components, although typically in a military or security context quite different from the resource management focus of the primary ocean agencies. Programs with ocean-related functions also exist within the Departments of Agriculture, Energy, Health and Human Services, Justice, Labor, State, and Transportation and in the National Science Foundation and the U.S. Agency for International Development.

Departments and agencies often support very similar or overlapping activities. In some cases, this programmatic overlap can provide useful checks and balances when agencies bring different perspectives and experiences to the table. Furthermore, some entities, such as the U.S. Navy, the U.S. Department of Justice, or the National Science Foundation, have such distinct missions that their ocean- and coastal-related components could not be simply removed and transferred without harm to the overall enterprise. Programs that are not suitable for consolidation will need to be coordinated through the National Ocean Council and the regional ocean councils.

However, during the 1970 reorganization that established NOAA, many ocean and coastal programs were left in other agencies. Since that time, ocean- and coastal-related programs have continued to proliferate throughout the federal government. In a number of cases, the number of separate agencies addressing a similar issue is not helpful. Such fragmentation diffuses responsibility, introduces unnecessary overlap, raises administrative costs, inhibits communication, and interferes with the development of a comprehensive management regime that addresses issues within an ecosystem-based context.

Departments and agencies with programs that may be appropriate for consolidation include the U.S. Department of the Interior (DOI), EPA, USACE's Directorate of Civil Works, and NASA. These agencies carry out important functions related to managing and protecting marine areas and resources, conducting science, education, and outreach, and carrying out assessment and prediction in the ocean, coastal, and atmospheric environments. In Phase II of strengthening the federal agency structure, judicious consolidation of ocean- and coastal-related functions will improve policy integration and program effectiveness.

Recommendation 7-3. The Assistant to the President, with advice from the National Ocean Council and the Presidential Council of Advisors on Ocean Policy, should review federal ocean, coastal and atmospheric programs, and recommend opportunities for consolidation of similar functions.

Specific recommendations on program consolidation can be found in Chapter 9 (area-based ocean and coastal resource management), Chapter 14 (nonpoint source pollution), Chapter 16 (vessel pollution), Chapter 17 (invasive species), Chapter 20 (marine mammals), Chapter 22 (aquaculture), and Chapter 26 (satellite Earth observing operations).

Because the legislative process to create or reorganize agencies is often contentious, lengthy, and uncertain, involving multiple committees in both houses of Congress, limited reorganization authority has been granted to the President at various times. In its 2003 report, the Volcker Commission supported the reinstatement of presidential reorganization authority, with suitable congressional oversight, to streamline improvements in the executive branch.[3] Allowing the President authority to propose expedited agency reorganization, with a congressional review and approval process that is timely, constitutionally valid, administratively workable, transparent, and accountable, would provide an excellent mechanism to achieve reorganization of federal ocean- and coastal-related agencies and programs more expeditiously.

Recommendation 7–4. Congress should authorize the President to propose structural reorganization of federal departments and agencies.

In particular, such legislation should:

- *require Congressional approval of the President's reorganization proposal before it can take effect.*
- *preclude Congress from amending the President's proposal.*
- *require Congress to vote on the President's proposal after submission of the plan by the President.*

Historical Precedent for Presidential Reorganization of the Executive Branch

By historical practice and case law interpretation, the President and Congress have operated on the premise that the power to establish, structure, and reorganize federal agencies is a legislative power, conferred on Congress by the U.S. Constitution. In the absence of a specific statute stating otherwise, the President lacks authority to reorganize executive branch departments and agencies.

Over the last one hundred years Congress has intermittently granted the President such authority, with a variety of restrictions and with provisions for expedited congressional approval or disapproval of the President's proposals. A total of eighteen reorganization acts were passed between 1932 and 1984.

In 1970, President Nixon used the authority of the Reorganization Act of 1949, which authorized the President to propose agency reorganization subject to congressional disapproval, to propose successfully the creation of the National Oceanic and Atmospheric Administration and the U.S. Environmental Protection Agency. The most recent presidential reorganization authority expired at the end of 1984.

MANAGING ALL NATURAL RESOURCES IN AN ECOSYSTEM-BASED MANAGEMENT APPROACH: PHASE III

Based on a growing understanding of ecosystems, including recognition of the inextricable links among the sea, land, air, and all living things, a more fundamental reorganization of federal resource agencies will eventually be needed.

As noted, the major ocean- and coastal-related functions of assessment, prediction, and operations, resource management, and research and education reside in a variety of agencies. Strengthening the performance of ocean, coastal, and atmospheric programs through coordination and consolidation are important steps in moving toward an ecosystem-based management approach. By immediately establishing the National Ocean Council and strengthening NOAA, followed by the consolidation of suitable ocean and coastal programs and functions, the nation will be poised to take a further step in strengthening the federal government structure.

Consolidation of all natural resource functions, including those applicable to oceans and coasts, would enable the federal government to move toward true ecosystem-based management. This could be implemented through the establishment of a Department of Natural Resources or some other structural unification that brings together all of the nation's natural resource programs.

Recommendation 7–5. Following the establishment of the National Ocean Council and the Presidential Council of Advisors on Ocean Policy, the strengthening of the National Oceanic and Atmospheric Administration, and consolidation of similar federal ocean and coastal programs, the President should propose to Congress a reorganization of the federal government that recognizes the links among all the resources of the sea, land, and air and establishes a structure for more unified, ecosystem-based management of natural resources.

Thirty Years of Proposals to Reorganize Federal Management of Ocean and Coastal Resources

Between 1971 and 2001, there were over twenty congressional proposals, two presidential proposals, and proposals by a federal ocean advisory committee, to improve the management of oceans and other natural resources within the federal government. Details of these proposals are shown below. The icons on the left correspond to Figure 7.1.

Ash Council Proposal (1971) for a Department of Natural Resources: The proposal of the President's Advisory Council on Executive Reorganization called for eight cabinet-level agencies, including a Department of Natural Resources, which would include an Oceanic, Atmospheric, and Earth Science Administration made up of the National Oceanic and Atmospheric Administration and the U.S. Geological Survey. The proposal was modified in 1972 to also address the nation's energy resources in the form of a Department of Energy and Natural Resources. Neither proposal was acted upon by Congress.

Moss Proposal (1973) for a Department of Natural Resources and Environment: The proposal (S.27) called for the creation of a new Department of Natural Resources and Environment, and transferred all of the functions of the Department of the Interior, the Water Resources Council, the Energy Research and Development Administration, the Nuclear Regulatory Commission, and the Federal Energy Administration to the new department. Various functions of the U.S. Department of Commerce (including NOAA), the Department of Defense (civil works and civil regulatory functions), the Department of Agriculture, the Department of Transportation, and the Environmental Protection Agency, were also to be transferred to the new department. The proposal was introduced again in 1975 (also S.27), but no action was taken on either proposal.

Dingell Proposal (1973) for a Department of Natural Resources: The proposal (H.R. 3249) called for redesignating the Department of the Interior as the Department of Natural Resources and moving NOAA to this department. No action was taken.

Holifield Proposal (1973) for a Department of Energy and Natural Resources: The proposal (H.R. 9090) called for establishing an executive department to be known as the Department of Energy and Natural Resources, with five administrations to include an Oceanic, Atmospheric, and Earth Sciences Administration. NOAA and several other agencies would be transferred to the new department, with a division of function among the five administrations. No action was taken.

McDade Proposal (1974) for a Department of Natural Resources: The proposal (H.R. 12733) called for redesignating the Department of the Interior as the Department of Natural Resources within which a National Oceanic and Atmospheric Agency would be established. No action was taken.

Tunney Proposal (1975) for a Department of Natural Resources: The proposal (S. 2726) called for establishing a new Department of Natural Resources in the executive branch, transferring all of the functions of the Department of the Interior, the Federal Energy Administration, the Federal Energy Research and Development Administration, and the Water Resources Council to the new department. Various functions of the Departments of Commerce, Defense, Agriculture, and Transportation would also be transferred to the new department. The proposal also called for the establishment of an Executive Office of Resource and Materials Policy and a Joint Congressional Committee on Energy, Materials, and the Environment. No action was taken on this proposal.

Ribicoff Proposal (1976) for a Department of Energy and Natural Resources: The proposal (S. 3339) called for establishing a Department of Energy and Natural Resources, headed by a Secretary of Energy and Natural Resources, to assume the nonregulatory functions of specified agencies dealing with the management and conservation of natural resources and energy research. It also proposed to establish, within the Executive Office of the President, the Natural Resources Council to facilitate communication among federal agencies responsible for natural resource management and policy and to recommend improvements in such management and policy. No action was taken.

Hollings Proposal (1976) for a Department of the Environment and Oceans: The proposal (S. 3889) called for creating a Department of the Environment and Oceans, transferring into this new department existing agencies such as the Environmental Protection Agency, NOAA, and the U.S. Coast Guard, as well as a number of services and programs from both the U.S. Army Corps of Engineers and the Department of the Interior, to deal with the nation's "common property resources." No action was taken.

■	**Percy Proposal (1977) for a Department of Energy Supply and Natural Resources:** The proposal (S. 591) called for reorganizing federal energy-related activities in the executive branch, temporarily establishing an Energy Policy Council and a cabinet-level Committee on Conservation to establish energy policy objectives. The proposal also called for establishing an executive Department of Energy Supply and Natural Resources, transferring energy and natural resources functions from the Department of the Interior, the Federal Energy Administration, the Energy Research and Development Administration, and the U.S. Forest Service to the new agency, and transferring additional functions to existing departments and agencies. No action was taken.
■	**Brooke Proposal (1977) for a Department of Environment and Natural Resources:** The proposal (S. 1481) called for creating a Department of Environment and Natural Resources, transferring all functions of the Environmental Protection Agency and the Department of the Interior to the new department. Additional authority with respect to oceans, vessel and facility pollution control, coastal zone management, and atmospheric services was also to be transferred to the new department. No action was taken.
■	**President Carter's Reorganization Proposal (1978) for a Department of Natural Resources:** The proposal called for a larger governmental reorganization, which included a new Department of Natural Resources, to address the problems being faced on a national scale in the area of natural resource development, with the mission of "managing the nation's natural resources for multiple purposes, including protection, preservation, and wise use." The composition of this new department would be a large part of the Department of the Interior, NOAA, the U.S. Forest Service, and a number of programs from the Department of Agriculture and the U.S Army Corps of Engineers' Directorate of Civil Works. Within the department would be created five administrations, one of which would be the Oceanic and Atmospheric Administration to include the functions of NOAA; the Bureau of Land Management's Outer Continental Shelf (OCS) program; the USGS Conservation Division's OCS program; U.S. Fish and Wildlife Service's anadromous fisheries and marine mammal programs; and the Bureau of Reclamation's Weather Modification program. This plan was not adopted.
◆	**National Advisory Committee on Oceans and Atmosphere (advisory to NOAA) (1971–87):** This body, created in 1971 as a result of the Stratton Commission, made a number of recommendations for reorganization. In its 1978 and 1979 reports, the National Advisory Committee on Oceans and Atmosphere recommended that "the President and the Congress should refashion the non-military federal structure dealing with the atmosphere, coastal zone, polar regions, and the oceans…[so as to] centralize programs and federal management elements…to improve control of activities relating to economic development, environmental protection, and scientific and technological capabilities in the oceans and affecting the atmosphere." These recommendations were never implemented.
◆	**Scheuer Proposal (1983) for an independent NOAA:** The proposal (H.R. 3355) called for establishing NOAA as an independent agency, granting the agency coordination responsibility for oceanic and atmospheric matters, and setting forth enforcement authority of the administration. No action was taken.
◆	**Forsythe Proposal (1983) for an independent NOAA:** The proposal (H.R. 3381) also called for establishing NOAA as an independent agency, granting it coordination responsibility for oceanic and atmospheric matters, and setting forth enforcement authority of the administration. The bill reported to the House from the Committee on Merchant Marine and Fisheries, but the proposal was never adopted.
◆	**Weicker Proposal (1987) for an independent NOAA:** The proposal (S. 821) called for establishing NOAA as an independent federal agency. No action was taken.
◆	**Lowry Proposal (1988) for an independent NOAA:** The proposal (H.R. 5070) called for establishing NOAA as an independent agency to administer features of U.S. policy with respect to civil oceanic, coastal, and atmospheric activities and programs and their administration. No action was taken.
▲	**Unsoeld Proposal (1993) for transfer of NOAA functions:** The proposal (H.R. 2761) called for transferring to the Department of the Interior of the following NOAA offices and assets: the National Ocean Service, the National Marine Fisheries Service, the Office of Oceanic and Atmospheric Research, the fleet of research and survey vessels; and the NOAA Corps. It also called for the transfer of components of the National Ocean Service that carry out coastal management and assessment programs to the Environmental Protection Agency. No action was taken.

▲	**Chrysler Proposal (1995) for transfer of NOAA functions:** After the House and Senate passed the Concurrent Resolution on the Budget for Fiscal 1996 (H. Con. Res. 67), which called for eliminating the Department of Commerce as part of a congressional effort to streamline government, increase efficiency, and save taxpayer dollars, Congressman Chrysler introduced H.R. 1756, proposing to eliminate various parts of NOAA and transfer other parts of the agency to other existing agencies as part of an overall proposal to dismantle and wind up the affairs of the Department of Commerce over a period of three years. As with other proposals of this magnitude, the bill was referred to eleven committees, involving an additional ten subcommittees. Several committee members strongly dissented in the House Committee on Ways and Means report (Rept. 104-260), but no specific mention was made about NOAA. Although several subcommittees discharged or reported on the bill, no further action was taken.
◆	**Abraham Proposal (1995, 1997) for an independent NOAA:** The proposal (S. 929) called for reestablishing NOAA as an independent executive entity, following the abolishment of the Department of Commerce and transferring the functions from the former NOAA to a new NOAA. It also set forth other administrative changes, as well as the coordination of environmental policy. The proposal was reported out of committee to the Senate floor, but action was never taken. Variations of this proposal were introduced again in 1997 (S.1226 and S.1316), but no action was taken.
▲	**Royce Proposal (1997) for transfer of NOAA functions:** This proposal (H.R. 1319), similar to earlier House proposals to dismantle the Department of Commerce, called for the termination of various parts of NOAA and the transfer of other parts of the agency to other existing agencies. No action was taken.
◆	**Royce Proposal (1997) for an independent NOAA:** This proposal (H.R. 2667) was similar to other House proposals to terminate the Department of Commerce, except that it called for creating an independent NOAA, to which any of the former NOAA's functions that were not already terminated or transferred to other agencies by the bill would be transferred. No action was taken.
▲	**Young Proposal (1998) for transfer of certain NOAA functions:** The proposal (H.R. 4335) called for transferring to the Secretary of the Interior the functions of the Secretary of Commerce and the National Marine Fisheries Service under the Endangered Species Act of 1973. No action was taken.
◆	**Royce Proposal (1999) for an independent NOAA:** The proposal (H.R. 2452) called for reestablishing NOAA as an independent agency in the executive branch, under the supervision and direction of an Administrator of Oceans and Atmosphere. Certain functions would be transferred to a new NOAA: National Marine Fisheries Service functions; all functions performed by the National Ocean Service, including the Coastal Ocean Program; National Environmental Satellite, Data, and Information Service functions; Office of Oceanic and Atmospheric Research functions; and National Weather Service functions. Other programs would be transferred to other existing agencies: coastal nonpoint pollution functions would be transferred to the Environmental Protection Agency Administrator; aeronautical mapping and charting functions would be transferred to the Transportation Administrative Services Center at the Department of Transportation; and functions relating to mapping, charting, and geodesy would be moved to the U.S. Army Corps of Engineers. This proposal was part of a larger proposal to terminate the Department of Commerce. It was introduced again in 2001 (H.R. 375). No action was taken on either proposal.

[1] U.S. Commission on Marine Science, Engineering, and Resources. *Our Nation and the Sea: A Plan for Action.* Washington, DC: U.S. Government Printing Office, 1969.
[2] National Commission on the Public Service. *Urgent Business for America: Revitalizing the Federal Government for the 21st Century.* Washington, DC: Brookings Institution Center for Public Service, 2003.
[3] Ibid.

U.S. COMMISSION ON OCEAN POLICY

PART III
OCEAN STEWARDSHIP: THE IMPORTANCE OF EDUCATION AND PUBLIC AWARENESS

Chapter 8: Promoting Lifelong Ocean Education

Strengthening the nation's awareness of the importance of the oceans requires a heightened focus on the marine environment, through both formal and informal education efforts. Curricula for kindergarten through 12th grade should expose students to ocean issues throughout their formal education, with the next generation of ocean scientists, managers, educators, and leaders being prepared through diverse higher education opportunities. In addition, because formal curricula only reach students for a limited time, informal education aimed at the entire population is needed to foster lifelong learning. An education office located under the National Ocean Council and empowered by federal agency leadership will provide a national focal point to improve ocean-related education efforts, facilitate coordination of ocean-related education among federal agencies, and enhance collaboration among the research community, state and local education authorities, and the private sector.

Strengthening the Nation's Ocean Awareness

A recent national survey indicates that the American public has only a superficial awareness of the importance of the ocean to their daily lives, let alone its importance to all life on the planet.[1] The ocean is a source of food and medicine, controls global climate, provides energy, supplies jobs, supports economies, and reveals information about the planet that cannot be gained from any other source. The ocean conceals the highest mountains and deepest canyons on Earth. Exploration of the ocean has revealed amazing organisms straight out of science fiction and entire ecosystems previously unknown to humankind. But the extent of what we do not know—what remains undiscovered—sparks the imagination. With so much of the marine environment still unexplored, the ocean can be viewed as the final frontier on Earth.

While most people do not recognize the number of benefits the ocean provides, or its potential for further discovery, many do feel a positive connection with it, sensing perhaps that the vitality of the sea is directly related to human survival. This connection can be a powerful tool for increasing awareness of, interest in, and responsible action toward the marine environment, and is critical to building an ocean stewardship ethic, strengthening the nation's science literacy, and creating a new generation of ocean leaders.

Ocean Stewardship

To successfully address complex ocean- and coastal-related issues, balance the use and conservation of marine resources, and realize future benefits from the ocean, an interested, engaged public will be needed. The public should be armed not only with the knowledge and skills needed to make informed choices, but also with a sense of excitement about the marine environment. Individuals should understand the importance of the ocean to their lives and should realize how individual actions affect the marine environment. Public understanding of human impacts on the marine environment should be balanced with recognition of the benefits to be derived from well-managed ocean resources. Because of the connection among the ocean, the atmosphere, and the land, inland communities need to be just as involved as seaside communities.

Science Literacy

Ocean-related education also has the potential to stem the tide of science illiteracy threatening to undermine the nation's health, safety, and security. The scientific literacy of U.S. high school graduates is well below the international average.[2] This progressive loss of literacy weakens the nation's ability to maintain its traditionally strong foundation in science and mathematics. Only 15 percent of American adults now describe themselves as well informed about science and technology issues.[3]

Children have a natural curiosity about the world around them. By the ninth grade, however, this innate interest has too often faded or been transformed into apprehension—or even fear.[4] Capturing children's attention early, and continually nurturing their inherent scientific curiosity, is critical to achieving scientific literacy and would be well served by employing the natural, multidisciplinary allure of the ocean as a basis for teaching science, mathematics, and engineering concepts.

This allure could be parlayed into higher achievement in other subjects as well. The influence of the ocean on nearly every aspect of daily life, and the central role it plays in the development of the nation, make ocean-based studies ideal for enhancing student performance in areas such as geography, history, economics, policy, and law. Strengthening science literacy, therefore, encompasses not only natural sciences, but a full suite of social sciences.

Future Ocean Leaders

The nation needs a diverse, knowledgeable, and adequately prepared workforce to enhance understanding of the marine environment and make decisions regarding complex ocean- and coastal-related issues. In 1929, the National Research Council emphasized that advances in ocean knowledge would depend on an ocean-related workforce sufficient in size and ability, with ample educational opportunities at its disposal.[5] In today's competitive world of knowledge-based, technology-driven economies, with increasing demands on ocean and coastal resources, this need is even more relevant and urgent.

The education of the 21st century ocean-related workforce will require not only a strong understanding of oceanography and other disciplines, but an ability to integrate science concepts, engineering methods, and sociopolitical considerations. Resolving complex ocean issues related to economic stability, environmental health, and national security will require a workforce with diverse skills and backgrounds. Developing and maintaining such a workforce will rely, in turn, on programs of higher education that prepare future ocean professionals at a variety of levels and in a variety of marine-related fields.

Crosscutting Themes

While this chapter is organized into several sections—a collaborative education network, K-12 education, higher education and the workforce, and informal education—problems identified in each of these areas often affect the others. For example, inadequate funding is a concern throughout K-12, graduate, and informal education. Likewise, increased coordination is needed within and among all educational areas. One critical issue that recurs throughout this chapter is the need to bridge the gap between the research and education communities. Ocean-based professional development for teachers, scientifically sound ocean-based curricular materials, and up-to-date information for the public are just a few of the educational concerns that will depend on strong, vibrant connections between researchers and educators.

Another focus of this chapter is the role of the federal government in education. Although states are the leaders in K-12 education, federal agencies are a critical component of the education community. Ocean agencies will need appropriate direction and resources to fulfill this important role.

BUILDING A COLLABORATIVE OCEAN EDUCATION NETWORK

To achieve meaningful, lifelong learning on ocean issues, the efforts of federal agencies, state and local authorities, nongovernmental entities, and professional societies with roles in education need to be better coordinated.

Participants in Ocean Education

Although not all ocean-related federal agencies have a specific education mission, most have made efforts to reach out to students, teachers, and the public to inform them about ocean issues, sometimes by adding ocean-related components to larger science and environmental education efforts. Agencies that have developed educational programs related to planetary, environmental, and scientific processes include the National Oceanic and Atmospheric Administration (NOAA), U.S. Navy, National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), U.S. Environmental Protection Agency (EPA), Minerals Management Service, National Park Service, U.S. Fish and Wildlife Service, and U.S. Geological Survey. These programs increase public understanding of the Earth's systems and the environment. While it is valuable for ocean-related information to be included as part of broader environmental and science education efforts, it is also important to support educational efforts that focus specifically on oceans, coasts, and the human relationship with them.

Of course, the U.S. Department of Education has the overarching responsibility of ensuring equal access to and fostering excellence in education across the nation. The department is engaged in a partnership effort with states and school districts to implement education reforms, including requirements that each state meet certain goals in core subject areas, such as science, math, and reading.

Two national-level ocean education programs of particular importance are the Centers for Ocean Sciences Education Excellence (COSEE) and the National Sea Grant College Program (Sea Grant). COSEE is an NSF initiative, with additional support from the Office of Naval Research (ONR) and NOAA, that has established a number of regional centers and a national office to create a coordinated program for ocean science education. Sea Grant, a partnership between NOAA and U.S. universities, is a national program implemented at the state level to further ocean-related research, education, and outreach.

While federal programs provide many opportunities for ocean-related education, education is essentially a state responsibility, and control is exerted primarily at the local level. Therefore, the interaction and involvement of education administrators at the state, district, and individual school levels will be fundamental to the success of any effort to use ocean-based examples to enhance student achievement.

Aquariums, zoos, and other informal education centers also provide the public with opportunities to learn about the marine environment. Teachers rely on these informal venues as another way to educate students about the oceans. The involvement of those who educate teachers, including subject-specific and professional development instructors, is critical to providing teachers the knowledge, confidence, attitudes, and ability to teach ocean-related information. A number of groups and associations also have a significant role in ocean-related education, including professional societies, such as the National Marine Educators Association (NMEA), the National Science Teachers Association, and the American Association for the Advancement of Science.

Coordinating Ocean Education

Despite the existence of many positive efforts, ocean education remains a patchwork of independently conceived and implemented programs and activities. These efforts cannot provide the nationwide momentum and visibility needed to promote sustained ocean education for students, teachers, and the general public. Within the federal government, there is little discussion of ocean education, even among those agencies with the greatest responsibility for ocean issues. Different programs and funding mechanisms are not coordinated and resources are seldom leveraged. Even within individual agencies, offices that have education components often do not collaborate or communicate.

Existing Coordination Efforts

Existing efforts at coordination have failed to take hold nationally. For example, NMEA is a national organization that brings together individuals concerned with marine-related education. However, it is strictly a volunteer initiative, with limited resources and capacity to develop, support, and sustain national-scale efforts. The Federal Task Force on Environmental Education, chaired by EPA, has had some success in bringing together federal agencies to support joint programs in environmental education. However, these programs tend to be relatively small in scale and scope, with limited attention devoted to ocean issues. The National Science and Technology Council's Committee on Science recently formed a Subcommittee on Education because of a recognized need for improved coordination of all educational programs among federal agencies. The subcommittee is intended to help reduce fragmentation and duplication and to bring about a coordinated set of programs. While this new body has the potential to unite agency education efforts, it too lacks an ocean focus.

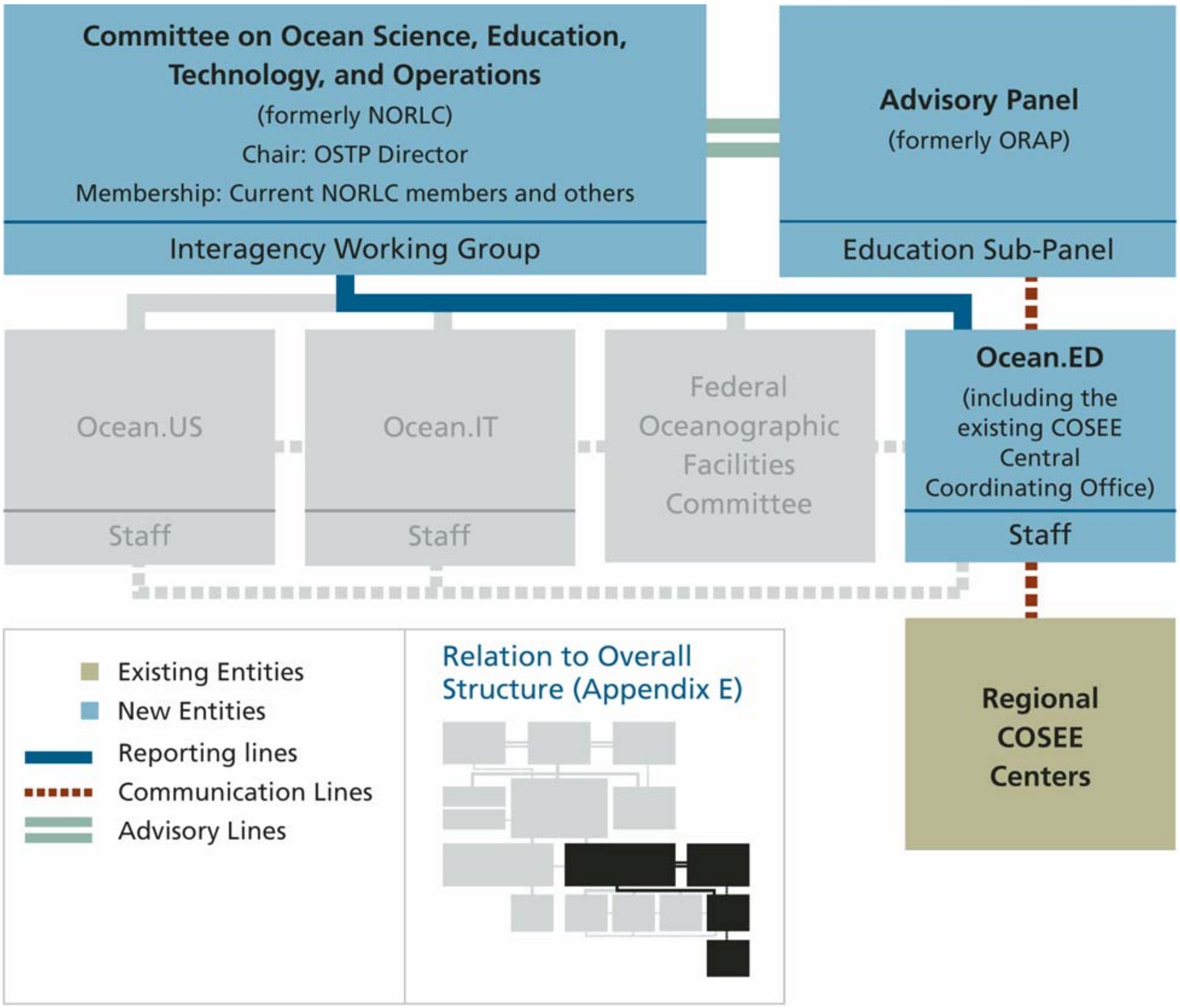
One program that does focus on ocean issues is the National Oceanographic Partnership Program (NOPP), a statutory collaboration of fifteen federal agencies intended to provide leadership and coordination of national oceanographic research and education programs. Primarily through its grant program, NOPP has provided support for innovative education and outreach projects. NOPP's Ocean Research Advisory Panel recently drafted a national ocean education strategy to improve ocean literacy and science education.[6] This strategy has great potential, but it has yet to be formally approved or adopted. Further, while NOPP has provided a venue for agencies to jointly fund ocean education activities, it does not provide a coordination mechanism for existing programs.

The coordination activities described above, while helpful, do not combine federal resources across agencies in a coherent, planned, and visible way. Without leadership, no common vision for ocean education has been developed, and no path for achieving such a vision has been laid out.

A National Ocean Education Office

As discussed in Chapter 4, the National Ocean Council, to be established within the Executive Office of the President, would serve as the federal coordinating body for all ocean-related activities. NOPP and its associated offices and committees would be incorporated within this structure. By strengthening and expanding NOPP's governing body (currently the National Ocean Research Leadership Council, but reconstituted pursuant to Recommendation 4-7 as the Committee on Ocean Science, Education, Technology, and Operations [COSETO]), and placing it under the National Ocean Council, the original NOPP goal of bringing agencies together on ocean research, operations, observing, and education efforts is more likely to be fulfilled. A national ocean education office would be an integral part of COSETO, serving as the education component of the enhanced NOPP (Figure 8.1). Such an office would coordinate the various federal ocean-related education efforts and perform many of the functions outlined in the education strategy crafted by NOPP's Ocean Research Advisory Panel. The education office would work closely with the other NOPP offices and committees, including Ocean.US, the office responsible for coordinating development of the Integrated Ocean Observing System which includes several education efforts.

Figure 8.1. Proposed Structure for the Coordination of Federal Ocean Education Activities



Shown here are the institutional components that should be established under the Committee on Ocean Science, Education, Technology, and Operations (COSETO; described in Chapter 4) to improve federal leadership and coordination in ocean education. This diagram also illustrates the organizational links between education components and other existing and planned units under COSETO. Entities shaded in gray are discussed in Chapter 25.

A national ocean education office would coordinate and integrate federal agency programs and leverage resources, serve as a central, visible point of contact for K–12, university-level, and informal education partners, and work with all parties to develop coherent, comprehensive planning for ocean education efforts. In doing so, the national office should also interact with the regional ocean councils, as one avenue for ensuring consideration of regional needs.

Recommendation 8–1. The National Ocean Council should establish a national ocean education office (Ocean.ED) under its Committee on Ocean Science, Education, Technology, and Operations to strengthen ocean education and coordinate federal education efforts.

In particular, Ocean.ED should have the following responsibilities:

- *development of a national vision for enhancing educational achievement in natural and social sciences and increasing ocean awareness.*
- *creation of a strategy to implement the vision, including promotion of creative programs that transcend the traditional mission boundaries of individual agencies, and guidance on investments in ocean-related education activities.*
- *development of a medium-term (five-year) national plan for ocean-related K–12 and informal education, working with federal, state, and nongovernmental education entities.*
- *coordination and integration of all federal ocean-related education activities and establishment of links among federal efforts, state and local education authorities, informal education facilities and programs, institutions of higher learning, and private-sector education initiatives.*

Recommendation 8–2. Congress should provide funding for Ocean.ED operations and program implementation as a line item in the National Oceanic and Atmospheric Administration (NOAA) budget, to be spent only at the direction of the National Ocean Council (NOC). NOAA should develop a streamlined process for distributing Ocean.ED funds to other federal and nonfederal entities as approved by the NOC.

This national effort is not meant to replace other successful programs and activities, but rather provide a mechanism for communication, coordination, and joining of forces. Once created, Ocean.ED will need staff support and sustained funding, and should be overseen by an interagency committee chaired by NOAA and reporting to the National Ocean Council. While Ocean.ED will focus on ocean-related education, these efforts will have a greater chance of success if they are linked with efforts to improve education in other subjects, including natural sciences, technology, engineering, math, and a range of social sciences. Therefore, participation should extend beyond the current NOPP agencies, including the Department of Education. The new education office will also need an external advisory body to ensure involvement of and communication with professional teaching organizations and other experts.

The ability of a national-level ocean education office to effectively coordinate and promote ocean education efforts depends on every ocean-related federal agency acknowledging education as a priority. NASA and NSF have long embraced this approach, but it has been more difficult for many of the more mission-oriented agencies. Nevertheless, NOAA's strategic plan for fiscal years 2003–8 includes environmental literacy, outreach, and education as a crosscutting priority[7] and the agency recently created an Office of Education and Sustainable Development to coordinate its education activities. By passing an organic act for NOAA that includes education as part of the agency's charge, as recommended in Chapter 7, Congress can encourage these positive developments.

Funding and Assessment

In addition to the functions of Ocean.ED outlined above, the office, working through the National Ocean Council process, should help ensure that adequate funding is available to carry out ocean-related education programs and activities. It should also work with the education community to develop a process for periodically assessing and evaluating ocean education efforts.

Sustained Support for Ocean Education

Adequate funding will be needed to meet the goals outlined in this chapter, but it is particularly important that funding for ocean-related education be sustained over time (for periods of at least five years) to allow programs to become established, produce results, and identify potential nonfederal funding sources.

Continuity of funding ensures that successful education efforts can be continued, expanded, and replicated. A dedicated, secure, sustained source of support for formal and informal ocean education efforts is needed to supplement existing low levels of ocean education funding. Such funding could be distributed through the existing NOPP funding process.

Evaluation and Assessment of Ocean Education Efforts

If ocean-based K–12, informal, and professional development programs are to serve as the basis for enhancing ocean awareness and increasing knowledge among students, educators, and the public, it will be critical to determine the effectiveness of these programs. For professional development efforts, accurate, properly conducted evaluation and assessment is vital to know how to modify existing programs and establish effective new efforts that provide educators with a productive and valuable experience. Likewise, identification and evaluation of best practices for incorporating ocean-based concepts into K–12 and teacher preparation coursework will help ensure continual improvement. Assessment mechanisms are needed to determine whether ocean-based coursework and programs are enhancing students' academic achievement and to promote materials and programs that provide the most enriching learning experiences.

Evaluation and assessment mechanisms are also critical to determining whether public education programs have been effective at delivering their messages. This information, combined with data on the state of public knowledge, provides the basis for program development and modification.

Recommendation 8–3. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should strengthen their support of both formal and informal ocean-related education, including appropriate assessments and evaluation of these efforts.

In particular, these agencies should:
- *develop, with assistance from Ocean.ED, a cooperative system of dedicated, sustained, multi-agency funding for formal and informal ocean education. This funding should be explicitly linked to the national ocean education plan.*
- *provide support for development and implementation of ocean-related education materials and activities with a requirement that evaluation and assessment mechanisms be included as a component of every program.*

Recommendation 8–4. Ocean.ED should lead the development of a framework for evaluating and assessing the effectiveness of ocean-related education programs, ocean-based K–12 professional development programs, best practices for incorporating ocean-based examples into K–12 education, and public education programs.

Linking the Research and Education Communities

Collaboration between the research and education communities must be improved if ocean-based information, including ocean data and new discoveries, is to be transformed into exciting and accessible materials to stimulate student achievement and enhance public awareness. Some efforts do exist to make these connections, most notably through the COSEE and Sea Grant programs.

Centers for Ocean Sciences Education Excellence

The COSEE network includes regional centers and a central coordinating office that work to integrate oceanographic data and information into high-quality curricular materials, provide ocean scientists with opportunities to learn more about educational needs and requirements, provide K–12 teachers with the knowledge and skills they need to effectively incorporate ocean-related information into their lessons, and deliver ocean-related information to the public.

Though recognized as a model for enhancing education and bringing accessible ocean-related information to the public, COSEE currently has only seven regional centers, each serving a limited number of schools in its area. The program does not have the level of committed, long-term support required to fully realize it's potential.

While COSEE is currently an NSF program, placing it within the National Ocean Council structure as a NOPP program would enable the other NOPP agencies to more easily support COSEE, capitalizing on the tremendous potential to enhance and expand the program. The placement of COSEE within NOPP should not alter the relationships established between the central coordinating office and the regional centers, or among the regional centers and their partners. Before COSEE is expanded significantly in scale and scope, the regional COSEE centers should be evaluated to ensure that all participating centers address educational needs most effectively.

Recommendation 8–5. The National Ocean Council (NOC), working with the National Science Foundation, should relocate and expand the Centers for Ocean Sciences Education Excellence (COSEE) within the NOC structure as a program to be organized, overseen, and funded through Ocean.ED.

Expansion of COSEE should include:

- *tripling the number of regional centers to 21, with each center receiving at least $1.5 million a year for an initial five year period.*
- *expanding the reach of each center beyond its immediate participants.*
- *identifying models for successful partnerships between scientists and K–12 teachers.*
- *devising strategies to incorporate the expertise of university science education specialists.*
- *implementing professional development programs for K–12 teachers and university research professors.*

The National Sea Grant College Program

The National Sea Grant College Program was created by Congress in 1966 as a partnership between the nation's universities and NOAA. Sea Grant programs sponsor research, education, outreach, and technology transfer through a network of Sea Grant Colleges and research institutions. Sea Grant uses the work of university scientists, educators, and outreach specialists to study marine and Great Lakes resource management, development, and conservation issues, and then shares that knowledge with coastal businesses, marine industries, government, educators, and the public.

Sea Grant has forged connections between the research and education communities since its inception. Its programs provide K–12 teacher preparation and professional development programs consistent with state education standards, offer hands-on educational experiences for students, and develop research-based curricular and communications materials for students and the public. The Sea Grant network relies on longstanding local partnerships, with many connections to populations that have been traditionally underrepresented and underserved by the ocean community.

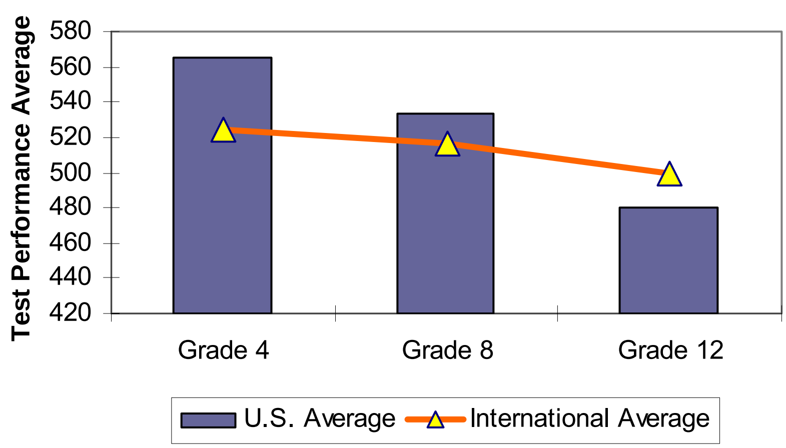
Despite its successes, however, Sea Grant is currently an underutilized resource. The existing Sea Grant network could expand its roles and responsibilities, particularly in education and outreach. Such an expanded and strengthened role is not possible with Sea Grant's current annual budget of just over $60 million. Funding for Sea Grant education initiatives is particularly limited, amounting to approximately 5 percent of the program's budget in fiscal year 2002 (excluding fellowship programs). Although Sea Grant is one of the few major education outlets for NOAA, not all state Sea Grant programs have even one full-time education professional on staff due to funding limitations. Because of the value of Sea Grant's educational activities, the program should be provided the resources to devote additional significant attention to that part of its charge. (An additional discussion of the Sea Grant program and the need to expand its capabilities is presented in Chapter 25.)

Because both the COSEE and Sea Grant programs play an important role in bringing together the research and education communities and both operate on national, regional, state, and local levels, there are natural links that could be established between them. While Sea Grant programs currently participate in many of the regional COSEE centers, these two programs could enhance their partnership by developing links in all of the regions in which they both operate. In addition, COSEE and Sea Grant should be closely connected with the regional ocean information programs discussed in Chapter 5.

Incorporating Oceans into K–12 Education

International studies show that the United States is not preparing its citizens to sustain and build on the nation's past scientific and technological accomplishments and compete successfully in an increasingly complex and technical world (Figure 8.2). At the same time, a lack of public awareness about the importance of the ocean hampers efforts to develop a balanced approach to the use and conservation of marine resources. Incorporating ocean-based learning experiences into K–12 education can help redress both these deficiencies.

Figure 8.2. U.S. Students Fall Behind in Science Knowledge

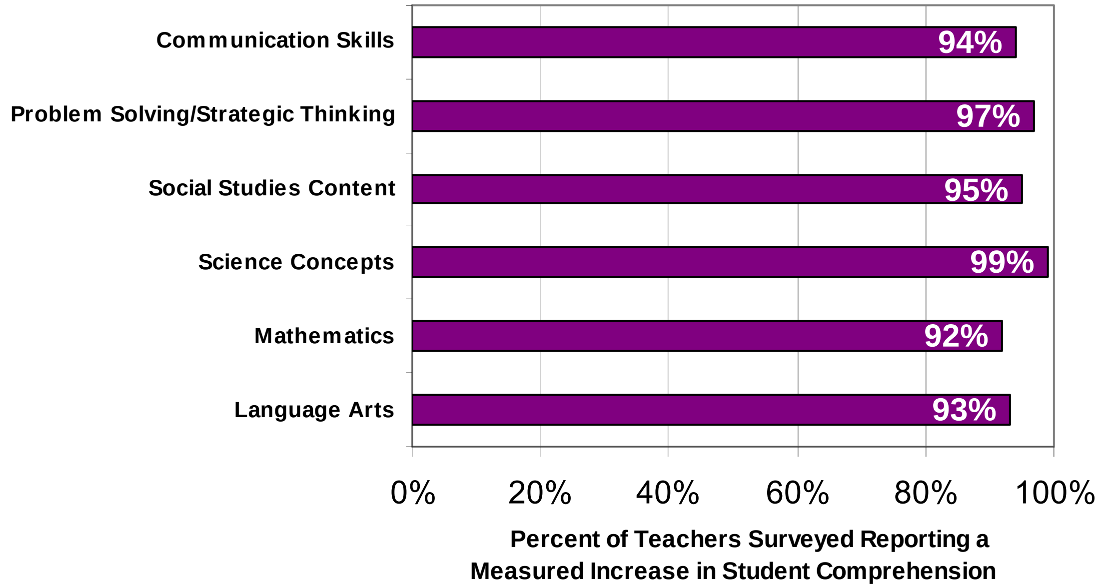


U.S. students at the fourth grade level score above the international average in science achievement, as calculated by test performance in the Trends in International Mathematics and Science Study. However, as students approach their final year in secondary school, the performance average in U.S. schools drops well below the international average.

Source: Calsyn, C., P. Gonzales, and M. Frase. *Highlights from TIMSS* [Trends in International Mathematics and Science Study]. Washington, DC: National Center for Education Statistics, 1999.

A study of forty schools in twelve states found that integration of environment-based programs into the overall education system increased student academic achievement in a number of areas (Figure 8.3), underscoring the power of using the student's world, including both natural and sociocultural environments, as a conduit for reaching and engaging students.

Figure 8.3. Environment-based Education Boosts Overall Academic Achievement



In a recent study, a high percentage of teachers reported increased achievement among students when natural and sociocultural environments were used as a context for learning a range of subjects.
Source: Lieberman, G.A., and L.L. Hoody. *Closing the Achievement Gap: Using the Environment as an Integrated Context for Learning*. Poway, CA: Science Wizards, 1998.

The passage of the No Child Left Behind Act in 2002 reemphasized education—including science education—as a national priority. With the laudable goal of improving educational quality and student achievement, the Act calls for all states to establish standards in various subjects, with science education standards required by the 2005–6 school year. To ensure that students are reaching the goals set for them, science achievement must be tested beginning in the 2007–8 school year. This requirement offers an opportunity to demonstrate how the oceans can excite students about science and other subjects by incorporating ocean-related concepts into K-12 curricular materials.

Using Ocean-based Examples to Meet Education Standards

There are two primary sets of science literacy guidelines at the national level: the American Association for the Advancement of Science's 1993 *Benchmarks for Science Literacy,* and the National Research Council's 1996 *National Science Education Standards (NSES)*. Despite similar goals of outlining what students should know, understand, and be able to do in science at various grade levels, the *Benchmarks* include ocean sciences and ocean-related issues, while the *NSES* contain few explicit references to the oceans or ocean sciences.

A recent survey revealed a clear preference among educators for using the *NSES* rather than the *Benchmarks* when aligning science lessons with instructional standards (Appendix 3). And where statewide science standards exist, they are also typically based on the *NSES*. Thus, the notion of using the oceans to meet science requirements is not commonly incorporated at the state or local level, slowing the adoption of ocean-based curricular materials in K-12 classes.

Nonetheless, while the *NSES* do not highlight oceans explicitly, they do endorse a new approach to teaching and learning science that emphasizes inquiry-based education as the ideal way for students to gain knowledge and an understanding of the world around them. The oceans are an excellent vehicle for implementing this new approach. The hands-on, interdisciplinary and multidisciplinary nature of ocean-based studies lends itself to teaching the basic principles of biology, chemistry, geology, physics, and mathematics in an engaging, novel manner. Principles of the core sciences, many of which are relatively abstract, become more tangible and easier to grasp when introduced through ocean examples.

The centuries-old ties between the marine environment and human experience make the ocean an equally powerful resource for teaching literature, economics, history, and other social sciences. Ocean-based examples focusing on these areas can be a valuable tool for K-12 teachers to not only enhance student achievement but educate young people on the many ways the oceans influence and are influenced by human activities.

The value of ocean-based learning must be recognized within local school districts to create a demand for ocean-related education products. A well-informed network will be needed to advocate inclusion of ocean-based examples in state and local requirements and assessments. This network could begin with organizations and efforts that have established local connections—such as COSEE, Sea Grant, NMEA, and the National Science Teachers Association—to serve as facilitators. A potential model to examine is NASA's education program, which involves translators and liaisons who work directly with teachers and administrators at the local level to produce high-quality, research-based curricula that are tailored to the needs of the school system and aligned with state and national standards. In addition, professional teaching and ocean-related societies should encourage their members to become active participants on boards and committees that decide content for statewide science achievement tests.

Because scientists typically do not know what type, level, or format of information K–12 teachers require, and because teachers generally are not aware of how ocean-related data can be used to advance student achievement, collaborative efforts will be needed to develop research-based, ocean-related curricular materials that are aligned with state and national educational standards and meet the needs of teachers.

Recommendation 8–6. Ocean.ED, working with state and local education authorities and the research community, should coordinate the development and adoption of ocean-related materials and examples that meet existing education standards.

Specifically, Ocean.ED should:

- *assess existing ocean-based curricular offerings, highlighting exemplary materials that are aligned with national standards.*
- *ensure the creation of National Science Education Standards companion materials that are based on ocean data and research findings (including social and economic fields); provide ocean-based examples and assessment questions that link to the concept standards in physical and life sciences, geography, history, and other topics; and clearly demonstrate the value of oceans in teaching fundamental concepts. Development of these materials should be coordinated with ongoing efforts by the National Marine Educators Association, the National Geographic Society, and others to establish basic ocean literacy concepts.*
- *promote the development of case studies that stress the interconnected nature of the ocean, land, and atmosphere.*

Bridging the Gap between Scientists and Educators

The extent to which the nation is able to enhance ocean awareness, boost student achievement, and prepare future generations of ocean professionals depends not only on the teachers and administrators who guide students on a daily basis, but on the commitment of the research community to prepare students to be responsible, knowledgeable, and competitive members of the global society. The National Research Council has highlighted the need for scientists to be fully engaged in the process of K–12 education in our nation, noting that teachers and researchers possess different strengths and resources and that they must be equally dedicated partners committed to improving educational opportunities.[8] As noted above, collaborations are needed in the development of ocean-related curricular materials, but they are also needed to broaden opportunities for students and teachers to gain first-hand field and research experience.

Teaching the Teachers

Higher expectations for our youth mean higher expectations for teachers as well. Students cannot achieve without instruction by capable teachers who are knowledgeable in the topics being presented. Thus, improving the quality of science and math education must begin with improving preparation of undergraduates studying to be teachers (referred to as pre-service teachers) and professional development for certified teachers in the classroom (referred to as in-service teachers).

The Need for Qualified Science Teachers

A 2000 National Research Council report confirmed that there is a strong relationship between the level of knowledge of science and math teachers and the achievement of their students in these areas.[9] Nevertheless, many science and math classes continue to be taught by unqualified or under-qualified instructors. Thirty-nine percent of public school students taking life science or biology classes in grades 7–12 are taught by teachers without even a minor in these fields, while 56 percent of grade 7–12 students in physical science classes are taught by teachers without even a minor in physics, chemistry, geology, or earth science.[10]

The lack of content knowledge among educators is particularly pervasive on ocean topics. The college science courses taken by pre-service teachers form the basis of their scientific understanding and determine their comfort level in teaching science. Because very few universities provide pre-service teachers exposure to ocean topics,[11] they remain poorly equipped to incorporate ocean-related concepts into their instruction.

Similarly, in-service teachers have few opportunities to learn about ocean concepts and how they can be introduced into lessons. First-hand, in-depth involvement of teachers in research and field experiences is a proven way to connect science teaching and science learning. The ocean research community is brimming with potential for engaging K–12 educators in the excitement and satisfaction of the scientific enterprise, and the nation's research infrastructure provides significant opportunities for formal preparation, hands-on involvement, and teacher certification. Although several public and private sector programs can provide teachers with research experience in ocean-related topics, access to these programs is quite limited, very few have long term, stable funding, and the different efforts are poorly coordinated.

For example, NSF's Research Experiences for Teachers program could be expanded to include ocean-based opportunities and NOAA could build on successful programs such as Teachers-at-Sea and Ocean Explorer. Federal ocean agencies could also provide incentives for ocean research institutions to establish certificate programs for pre-service and in-service teacher preparation and development and include graduate courses that cover ocean-related concepts and how they can be applied in teaching. To help broaden the impact of such professional development programs, successful participants should be encouraged to serve as master teachers or resource teachers after a period of evaluation. The American Meteorological Society's Project Maury and Project Atmosphere serve as excellent models for achieving this type of long-term impact.

Despite an abundance of good ideas and successful models, significant obstacles remain in developing lasting collaborations between ocean scientists and teachers. A 1996 National Research Council report found that researchers do not fully appreciate the roles and responsibilities of teachers, and teachers are not fully aware of the duties and functions of researchers.[12] Further, the existing academic culture can be a deterrent to scientists' involvement in education and outreach activities. Although most faculty are expected to participate in research, teaching, and service activities, universities typically provide the greatest rewards for successful research, with teaching achievements a distant second, and little if any recognition for community service.

COOL Professional Development for Teachers

A partnership between the Jacques Cousteau National Estuarine Research Reserve and the Rutgers University Institute of Marine and Coastal Sciences generates a wealth of professional development opportunities designed to engage New Jersey teachers and school administrators in using the ocean to enhance student learning experiences. Programs range from field-based workshops to Web-based instructional modules dubbed the COOL (Coastal Ocean Observation Laboratory) Classroom. This partnership is an example of the type of innovative, relevant, and exciting educational opportunities that can be created when the research and education communities work together to bring the latest advances in ocean research into the classroom.

Federal agencies could help bring about a cultural change by providing incentives for universities to raise the visibility and rewards for faculty interactions with educators. Programs such as NSF's Faculty Early Career Development program and Graduate Teaching Fellows in K–12 Education program address this issue by providing support for involvement in K–12 education among graduate students and young faculty. But the limited size and scope of these programs have restricted their influence.

Effective partnerships between scientists and teachers will require new, long-term arrangements between the academic community and school districts. Large-scale programs such as NSF's Math and Science Partnership, which funds university scientists to work with teachers in areas such as professional development and curriculum enhancement, are urgently needed. The COSEE and Sea Grant networks could be tapped to coordinate such programs within the ocean community.

Recommendation 8–7. Ocean.ED, working with academic institutions and local school districts, should help establish stronger and more effective relationships between the research and education communities to expand professional development opportunities for teachers and teacher educators. The National Oceanic and Atmospheric Administration, National Science Foundation, the U.S. Navy, and National Aeronautics and Space Administration should support these efforts by providing secure and stable funding.

Specifically, these agencies should:

- *provide supplemental grants and other rewards to scientists who partner with teachers and teacher educators to include educational components in their research projects.*
- *establish a grants program for development and implementation of an enhanced core curriculum in science content that incorporates ocean concepts for pre-service teachers. Applicants should be required to demonstrate collaborations and partnerships among education, science, mathematics, and engineering faculty.*

Bringing Oceans and Students Together

Through field and laboratory experiments, oceans offer a natural avenue for students to gain first-hand exposure to science while developing an awareness of the importance of the ocean. Not all students are near, or able to travel to, the shore, but new ocean research technologies represent a tremendous and virtually untapped avenue to overcome this limitation, allowing students anywhere to be involved in real oceanographic investigations. The same remote-access technologies that make advanced ocean research possible can also help students and teachers participate in collecting, analyzing, and distributing ocean data. Enabling students to interact with practicing scientists, even if they are thousands of miles away, can help create a lifelong affinity for learning.

Today's Kids … Tomorrow's Ocean Professionals

With regular field trips beyond the resources of most educators and school systems, the KidScience program serves as a model for bringing science to students through dynamic, relevant programs broadcast directly into classrooms. Produced cooperatively by the Hawaii Department of Education and Hawaii Public Television, this live, interactive series offers students in grades 4–8 two distinct types of learning opportunities.

Locally broadcast programs demonstrate hands-on lessons that involve students in a range of research activities and allow them to communicate with their on-screen instructor by telephoning or e-mailing questions throughout the broadcast. A more in-depth examination of selected topics takes place during three-part series that are broadcast not only in Hawaii but also in Micronesia and American Samoa and across the continental United States. These series combine live discussions with experts and pre-taped virtual field trips to expose students to topics ranging from "The Underwater Classroom" to "Living on a Volcano." Students are also engaged in current events involving ocean and coastal environments through discussions of ocean-related policy questions.

The potential benefits of technological advances for science education should be further explored to help U.S. students regain their position among the best and brightest in the world. Federal agencies and academic institutions should find ways to provide students with opportunities to participate in ocean research and exploration, virtually or in person, including summer programs, field trips, remote participation in ocean expeditions, and, most important, after-school activities. Mentoring, especially near-peer guidance, is critical and should be a component of any student-oriented program.

Engaging Underrepresented and Underserved Groups

Social, economic, and cultural factors can play an influential role in inhibiting a student's access to education opportunities, especially science-based opportunities. These factors are typically even stronger among minority students and other groups that have been traditionally underrepresented and underserved in scientific fields, including marine sciences. Repairing this broken link will depend on exposing minority students to ocean-related studies early in their education, continuing that exposure throughout their school years, and demonstrating the possibilities and rewards of a career in ocean-related fields.

Enhancing the appeal and viability of ocean-related careers among traditionally underrepresented and underserved groups will not happen overnight. Such efforts will need to address social and cultural issues and must demonstrate the relevance and importance of the oceans in daily life. Success depends on students, their families, and their communities embracing an ocean career as "viable, socially responsible, and financially rewarding."[13]

Recommendation 8–8. Ocean.ED should promote partnerships among school districts, institutions of higher learning, aquariums, science centers, museums, and private laboratories to develop more opportunities for students to explore the marine environment, both through virtual means and hands-on field, laboratory, and at-sea experiences. Ocean.ED should ensure that ocean-based educational programs and materials acknowledge cultural differences and other aspects of human diversity, resulting in programs that expose students and teachers from all cultures and backgrounds to ocean issues.

Investing in Higher Education and the Future Ocean Workforce

Understanding the marine environment and meeting our many ocean-related societal needs will require a well-trained, diverse workforce, adequate in number, with expertise across a range of ocean-related subjects. In addition to acquiring scientific knowledge and research skills, the ocean leaders of the future need to engage interdisciplinary and multidisciplinary perspectives, use multiple contexts in solving problems, and communicate complex ideas to a broad audience. Fostering these critical abilities requires diversification of learning opportunities.

Stagnant or declining federal support for ocean-related research has eroded the ability of academic institutions to maintain certain educational programs, limiting the breadth of educational opportunities. For example, there are few vibrant schools of fishery science and management, though advances in these areas are critical to successful fishery management efforts. Likewise, strong graduate educational efforts in marine taxonomy and biodiversity are very limited, though understanding of these topics is a baseline for ensuring scientifically sound management decisions.

The graying trend in the existing federal and academic ocean workforce adds to the urgency of training new ocean professionals. Projections of federal retirements indicate that just over 30 percent of federal employees will leave the workforce in the next decade.[14] This trend will result in the loss of a great deal of the intellectual power and creativity that has expanded our understanding and improved management of the marine environment. The nation will require a human resource base capable of building on advances of the past to solve the problems of tomorrow.

The Leadership Void

There is no lead federal agency to assess, nurture, and maintain a strong ocean workforce, both in numbers and in diversity of skills. As the nation's primary civilian ocean agency, NOAA would seem a natural candidate to fill this void. However, NOAA's involvement in education, which is generally limited to grant-specific research assistantships and a handful of policy and industry fellowships, falls far short of the effort needed on a national scale. NOAA provided only 18 percent of federal support for ocean-related academic research programs (on which much graduate student funding depends) for the 2001–2 academic year (Appendix 4). This level of support is inadequate given that NOAA is a major employer of ocean professionals. The approach is markedly different at the National Institutes of Health, which works hard to ensure a sufficient and knowledgeable workforce for the health sciences community.

The Navy, predominantly through ONR, has traditionally been a leader in supporting ocean-related graduate student education. However, Navy funding for academic-based basic ocean research has been on a downward trend.[15] This leaves NSF as the primary supporter of ocean science graduate students, providing 36 percent of federal support for ocean-related academic research programs for the 2001–2 academic year.[16] While education is a part of NSF's mission, the agency's proposal-driven approach is not ideally suited to meet identified national needs for ocean-related education and training. Furthermore, NSF graduate student support tends to emphasize the natural sciences and engineering, a component—but not all—of the ocean workforce. (A detailed overview of federal agency funding for academic ocean science programs can be found in Appendix 4.)

Academic institutions must also take responsibility for meeting future ocean-related workforce needs. Redesigned graduate programs can expose students to aspects of the marine field outside their primary focus, for example, exposing science students to policy issues and policy students to the scientific process. Ocean-related graduate programs should develop cross-disciplinary opportunities, partnering with other programs (for example in education, public policy, economics, communications, resource management, and engineering) in universities, federal facilities, or private laboratories.

Drawing Students into the Field

The ocean community must compete with countless other professions in attracting the talent it needs. Success lies, in part, in promoting marine-related career opportunities among undergraduate students from a broad range of disciplines. First-hand experiences in marine fields can be influential in demonstrating the possibilities and rewards of an ocean-related career. Intellectually stimulating and financially attractive options for pursuing graduate studies in an ocean-related field must follow, so a student's developing interest in ocean studies is not overshadowed by other professions that actively pursue, encourage, and support their future leaders.

Ocean sciences have another potentially important role to play at the undergraduate level. Marine science courses can be attractive options for non-science majors who need to fulfill science requirements for graduation, presenting an excellent opportunity to raise general ocean awareness.

Recommendation 8–9. The National Oceanic and Atmospheric Administration, National Science Foundation, and Office of Naval Research should support colleges and universities in promoting introductory marine science courses to expose students, including non-science majors, to these subjects.

These agencies should support this effort by:

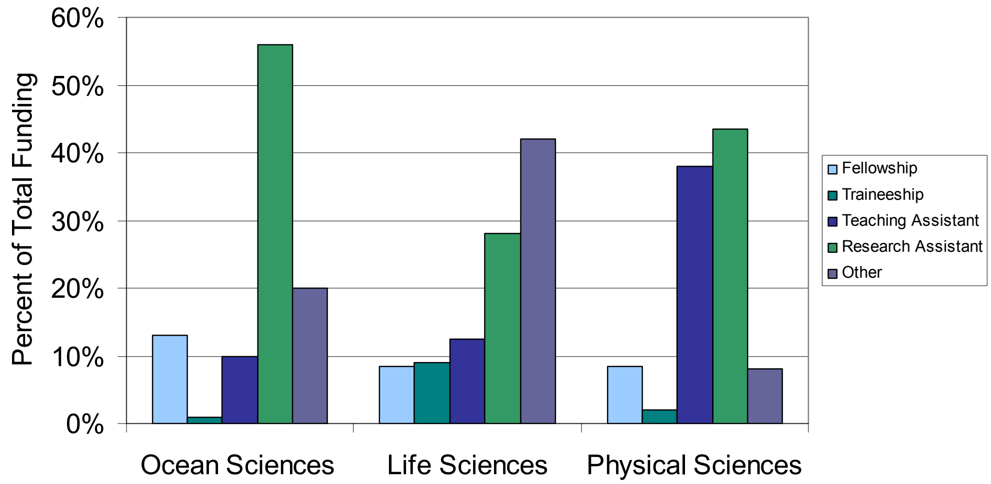
- *providing small grants to assist in course development, equipment purchase, faculty support, and field experiences.*
- *fostering collaborations between institutions with graduate ocean programs and others with a primarily undergraduate population.*

Expanding Graduate Educational Opportunities

How students are funded significantly influences their opportunities to develop research, engineering, teaching, management, and other skills. It can also limit or expand their awareness of the career paths and job sectors available to them. More than 55 percent of ocean sciences graduate students are supported by research assistantships, making the ocean community more dependent on this type of support than other fields (Figure 8.4). This is particularly striking in comparison with the life and physical sciences, in which students are supported through a more diversified combination of opportunities including traineeships, fellowships, and teaching assistantships.[17]

Research assistantships are important for budding scientists and should continue as a major student support mechanism. However, the ocean community's over-reliance on research assistantships can limit students' exposure to cross-disciplinary experiences that could better prepare them for addressing complex marine-related issues.

Figure 8.4. Graduate Students in Ocean Sciences Limited by Funding Source



When compared with the physical and life sciences, graduate programs in ocean sciences rely more heavily on research assistantships as a source for funding. Because of the requirements placed on students receiving this type of funding, they are potentially denied access to multi-disciplinary experiences that could better prepare them for examining complex marine-related issues.
Source: CORE Study: U.S. Academic Infrastructure in Support of Research and Education in Ocean Sciences and Related Fields, Appendix 4.

The ocean community could benefit from a better mix of fellowship and trainee programs. Fellowships allow top students to select a program best suited to their needs and interests. Traineeships allow graduate students to be assembled in a highly qualified research and learning environment. Student opportunities can also be diversified by getting both funding agencies and academic institutions to redefine what graduate research assistants are allowed to do. The NSF Integrative Graduate Education and Research Training program is an example of one attempt to move in this direction.

Because ocean science is fundamentally interdisciplinary, well-trained ocean professionals can find excellent careers in many areas including engineering, economics, education, law, management, policy, science, and technology. Individuals considering or pursuing graduate studies in a marine field should be aware of these options, and exploration of nontraditional marine areas should be encouraged. Equally important, professionals educated and trained in other fields should be made aware of the exciting opportunities available to them in marine-related fields.

Complementing the need to create an adequate workforce is the need to sustain and enhance that workforce through professional development and continuing education opportunities. Learning does not stop once the formal education process is complete; ocean professionals in all fields must be provided the means and liberty to continually build upon their knowledge and skills throughout their careers.

Recommendation 8–10. Ocean.ED should guide and promote the development of the nation's ocean-related workforce.

In particular, Ocean.ED should:

- *promote student support, diversified educational opportunities, and investment in innovative approaches to graduate education that prepare students for a broad range of careers in academia, government, and industry.*
- *encourage, with targeted federal support, graduate departments of ocean sciences and engineering to experiment with new or redesigned programs that emphasize cross-disciplinary courses of study.*
- *set targets for federal stipends for ocean-related education to be competitive with other disciplines.*

Workforce Needs

As discussed above, most graduate ocean education has been linked to faculty research, an approach that pays little or no heed to the needs of the ocean-related workforce—which are poorly understood—or to national demographics, which are better understood but not well integrated into workforce preparation.

While the U.S. Department of Labor plays a role in assessing workforce status and trends, currently there is no data collection or analysis of ocean-related workforce supply or demand, including requirements for the maritime transportation system. Only sketchy information is available on how many new ocean professionals are being produced and in what fields. In a recent survey of ocean-related higher education programs, 26 percent maintained no data on initial employment of recent graduates.[18] Even less effort has been put into projecting the types of professionals the ocean community will require in the future.

Federal ocean funding agencies will continue to operate in the dark without improved information on the status of the ocean-related workforce, with periodic follow-up to determine whether workforce needs are being met. Some of the necessary data can be found through the Department of Labor, NSF, and others, but additional analyses and a tracking mechanism will be needed. The Consortium for Oceanographic Research and Education survey of academic institutions can help in developing this tracking mechanism (Appendix 4).

Recommendation 8–11. The National Oceanic and Atmospheric Administration and the U.S. Department of Labor should establish a national ocean workforce database and compile an annual report for the National Ocean Council on trends in ocean-related human resource development and needs. This effort should include an information clearinghouse to facilitate career decisions, provide access to career guidance, and enable employers, guidance counselors, and others to develop effective strategies to attract students to ocean-related careers. Ocean.ED should organize an ocean workforce summit every five years to address the alignment of ocean education with workforce needs.

Specific Federal Responsibilities

Each federal agency with ocean-related responsibilities—most notably NOAA, NSF, and ONR—has a responsibility to help ensure a vibrant ocean-related workforce. These agencies need to develop interrelated and crosscutting educational opportunities at the undergraduate, graduate, and postdoctoral levels.

NOAA should be particularly concerned with creating a pipeline of students in areas it identifies to be of critical importance to the agency. Opportunities should include both research experiences, especially exposure to mission-oriented research, and experiences beyond the research arena. Student exposure can begin as early as the junior or senior level in high school, continuing through postdoctoral education. A range of programs will help identify and recruit the best and brightest to careers in marine-related fields and ensure a continuing source of essential human capital.

At the graduate and postdoctoral levels, NOAA can support fellowships and traineeships that emphasize interdisciplinary approaches and real-world experiences beyond the university setting, such as those provided by the Dean John A. Knauss Marine Policy Fellowship, the NOAA Coastal Services Center Coastal Management Fellowship, and the American Association for the Advancement of Science Fellowship. NSF's Integrative Graduate Education and Research Training program and NASA traineeships and fellowships offer other models. Within NOAA, Sea Grant plays a critical role in providing graduate-level education opportunities, a role which could be enhanced as part of an expansion of that program.

Recommendation 8–12. The National Oceanic and Atmospheric Administration (NOAA) should establish a national ocean education and training program, patterned after the National Institutes of Health model, within its Office of Education and Sustainable Development to provide diverse, innovative ocean-related education opportunities at the undergraduate, graduate, and postdoctoral levels.

Specifically, NOAA should:

- *support fellowships and traineeships at the graduate and postdoctoral levels that emphasize interdisciplinary approaches and real-world experiences outside the university setting, especially in areas critical to the agency's mission.*
- *offer students at the undergraduate level experiential learning opportunities in a range of marine fields through summer internships or similar mechanisms.*

Also important is the need to encourage a recommitment to ocean studies within the academic community, particularly in areas critical to agency missions. The Navy has had success in partnering directly with academic institutions, providing support for distinguished scientists who, in turn, develop laboratories and educate students in areas of fundamental interest to the Navy. NOAA should establish similar competitive "Distinguished Professorships in Marine Studies" within Sea Grant Colleges or other leading institutions of higher education with a demonstrated commitment to marine programs. Disciplines of interest to NOAA for such professorships could include fisheries science, climate research, atmospheric studies, and marine resource economics, policy, aquaculture, genomics, education, and ecosystem studies. The intent would be to create a cadre of distinguished NOAA endowed chairs at universities around the nation. In a complementary effort, NOAA should consider establishing competitive national awards to recognize excellent teaching in marine-related topics.

At the undergraduate level, NSF's Research Experience for Undergraduates program could be expanded to include more marine-related experiences. At the graduate and postdoctoral levels, opportunities could include fellowships that encourage cross-disciplinary research, interdisciplinary traineeships, and master's degree fellowships. Programs such as NSF's Integrative Graduate Education and Research Training program, Centers for Learning and Teaching, and Graduate Teaching Fellows in K–12 Education should be supported and enhanced both within NSF and adopted by other federal ocean agencies.

Recommendation 8–13. The National Science Foundation's Directorates of Geosciences, Biological Sciences, and Education and Human Resources should develop cooperative programs to provide diverse educational opportunities at the undergraduate, graduate, and postdoctoral levels in a range of ocean-related fields.

The success of the Navy depends on a well-developed understanding of the environment in which it operates. Understanding the ocean environment—including the atmosphere above it, the seafloor beneath it, and the coastlines that encircle it—will always be a core naval requirement. Thus the Navy should play a central role in ensuring support for the education of future generations of ocean professionals.

Recommendation 8–14. The Office of Naval Research (ONR) should reinvigorate its support of graduate education in ocean sciences and engineering. This could be partly accomplished by increasing the number of ocean-related awards made under ONR's National Defense Science and Engineering Graduate Fellowship Program.

Strength through Diversity

Human diversity has the power to enrich and invigorate the ocean community with a range of perspectives critical to the overall capabilities of the ocean workforce. Science and management professionals who are part of a particular cultural or ethnic community can help to engender understanding of marine-related issues within their communities and can serve as role models to help young people envision themselves as future ocean professionals. Nearly 90 percent of students enrolled in U.S. ocean-related graduate programs during the fall of 2001, however, were identified as white.[19]

While a number of minority-serving institutions (MSIs) offer degree-granting programs in marine sciences, only the University of Puerto Rico offers a Ph.D.-level program.[20] This could be a contributing factor to the lack of minority representation among ocean professionals with advanced degrees. In the United States, historically black colleges and universities enroll only 12 percent of all African American college students, but they award 40 percent of the science degrees earned by African Americans.[21] There is great potential for building on this success and developing more avenues for underrepresented and underserved students to pursue advanced ocean-related studies. Member schools of the Hispanic Association of Colleges and Universities provide a similar opportunity for engaging Hispanic students in marine-related careers, as do tribal colleges and universities in the American Indian Higher Education Consortium.

One avenue that should be explored is support for collaborative programs that partner MSIs with research institutions to develop more graduate-level marine science programs at MSIs. One successful existing program that should be expanded to provide opportunities for more underrepresented and underserved students is NOAA's Educational Partnership Program with MSIs. A central element in this and similar programs must be the establishment of links between students and minority ocean professionals through a mentoring program.

While efforts should be made to expand opportunities for marine-related study at MSIs, all institutions need to provide an environment of cultural acceptance and instructional dedication to move students from diverse backgrounds forward academically.

Recommendation 8–15. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should encourage and increase the participation of traditionally underrepresented and underserved groups in the ocean-related workforce. Ocean.ED should facilitate collaboration between these agencies and institutions of higher learning to ensure that the appropriate mix of programs and opportunities exists to provide underrepresented and underserved groups ample access to and support for pursuing ocean-related graduate education.

Bringing the Ocean and Coasts to All Americans

While the public has a general sense that the ocean is important, most people lack a full awareness and understanding of the ocean, its health, the benefits it provides, and its connection to the nation's collective well-being. This information gap is a significant obstacle in achieving responsible use of our nation's coastal and ocean resources, empowering public involvement in ocean-related decision making, and realizing support for wise investments in and management of ocean-related activities.

The Ocean Information Gap

According to a recent national survey on ocean awareness, nearly 60 percent of Americans do not realize that more plants and animals live in the oceans than on the land; 75 percent mistakenly believe that forests, rather than oceans, are the major source of oxygen on the planet; and 40 percent are unaware of the essential role oceans play in regulating climate.[22]

Although a healthy marine environment is a prerequisite for our continued enjoyment of ocean and coastal benefits, a recent survey shows that many people consider the health of the marine environment a second-tier environmental concern, overshadowed by the problems of air and water pollution and toxic waste disposal. The American public apparently feels little sense of urgency safeguarding our coastal and ocean resources. In addition, while most Americans realize the marine environment can be degraded as a result of human activities, they are less clear about the role individuals play in contributing to this damage. Nearly half the public mistakenly agrees with the statement, "What I do in my lifetime doesn't impact ocean health much at all."[23]

Multifaceted Approaches

Such public misinformation points to the urgent need for raising awareness about the oceans. This Herculean task is currently being undertaken by a number of informal education facilities and programs, publicly and privately funded, struggling to make headway in advancing public knowledge about the marine environment.

The strength of the informal education community lies in the diversity of methods used. The varied formats, styles of presentation, and depth of detail, coupled with wide-ranging modes of access, result in an array of opportunities for reaching the public. Informal education facilities such as aquariums, science centers, zoos, museums, and marine parks, along with other outlets such as national magazines and television programs, local newscasts, traveling exhibits, and Internet sites, are all important contributors to the domain of public education.

What is Informal Education?

The National Science Foundation describes informal education as the life-long learning process in which every person acquires knowledge, skills, attitudes, and values from daily experiences and resources in his or her environment. Informal learning is self-directed, voluntary, and motivated mainly by intrinsic interest, curiosity, exploration, and social interaction.[24]

U.S. aquariums, zoos, and other informal education centers welcome over 135 million visitors a year to their on-site displays and bring information to millions of additional guests through community outreach efforts.[25] These informal education centers endeavor to be equal opportunity teachers by employing mechanisms and instituting programs to reach traditionally underrepresented and underserved groups. Natural history museums and science centers also provide ocean-related educational experiences to millions each year. These facilities have a reputation for delivering accurate information about the marine environment and represent a powerful voice in the realm of public education. A recent public poll revealed that aquariums are a highly trusted source of environmental information.[26]

In addition to informal education facilities, federal ocean-related agencies conduct public education and outreach. Opportunities range from first-hand exploration of the marine environment at a variety of marine sanctuaries, parks, and reserves to interactive Web sites that follow oceanographic expeditions in real time, to materials that translate scientific discoveries and relate them to everyday life. Federal agencies also support informal education by funding projects that aim to increase public understanding of scientific and environmental issues. (Additional information on a sampling of programs and activities offered by informal education facilities and federal agencies is provided in Appendix 5.)

Coordinating Messages

While the many existing informal education efforts have made progress, they have not yielded the level of national consciousness needed to cultivate a broad sense of responsibility toward the use and conservation of the nation's marine resources. As discussed earlier in this chapter, lack of leadership and coordination, in both message and action, and lack of funding are usually cited as the most significant barriers to realizing the full potential of informal education efforts.

Although all ocean-related informal education efforts have a common goal, they generally lack the coordination, connectivity, and leveraging of resources needed to achieve the greatest long-term impact. While nascent efforts are working to bring about better collaboration among aquariums and other informal education facilities, additional leadership will be needed to realize a focused and coordinated informal education network for ocean and coastal information. Government agencies, aquariums, academia, professional societies, and all others involved in public education must play a role in coordinating messages on the importance and significance of oceans. A team approach will increase the longevity, breadth of delivery, and integration of messages coming from many sources.

Coordination is also needed between the informal and K-12 education communities. Informal education efforts can provide information that is used to develop K-12 classroom lessons and activities. While many aquariums and museums now routinely create programs that are linked to state and local education standards, a stronger connection between informal and K-12 education efforts is needed, and the requirements of K-12 educators and students should be a constant consideration.

Funding for ocean-related informal education is a major concern. At the federal level, there is no dedicated source of funding for ocean-related informal education initiatives. While NSF, EPA, and other federal agencies support informal education, the programs are relatively small and do not focus on ocean-related activities.

The kinds of aquarium and science center exhibits most likely to have significant impacts are costly to assemble. Without outside public or private support, aquariums and similar facilities are often forced to focus on those topics that draw the greatest attendance, generally marine biology rather than the chemistry, physics, or geology of the marine environment. Enhanced funding would allow facilities to present a more complete picture of the marine environment and even illustrate the application of scientific understanding in managing ocean resources.

Broad Outreach

Public information needs are as varied as our population is diverse. Some individuals will benefit from detailed information on how specific issues directly affect their jobs or business. Others may need information presented in a language and media tailored to their culture and community. Still others seek advice on how to alter their own activities to support responsible ocean stewardship. This information is as critical for those who live in the heartland as for those who live near the shore.

Equal Opportunity Educators

The Splash Zone program at the Monterey Bay Aquarium is one example of an informal education effort designed to reach and engage underserved members of the community. The program was developed in part to enhance Hispanic attendance, membership, and participation at the aquarium, which were far below their proportion in the Monterey area population.

The Splash Zone exhibit on coral reef ecosystems and the rocky shore forms the basis for additional educational activities and materials. Working with local Head Start offices, the aquarium is better able to reach and focus on Hispanic children and their families. The knowledge gained during visits to the aquarium is continued in the classroom. Appropriate activities and curricula are demonstrated to Head Start and other kindergarten through second grade educators during a week-long Teachers Institute. In addition, the program includes outreach to the schools through bilingual aquarium educators and family science nights in the neighborhood community center.

To continue the educational experience of the Splash Zone program, families can take advantage of the Shelf to Shore program. This complementary effort, conducted in cooperation with local libraries in largely Hispanic communities, allows individuals to check out a free aquarium pass for the entire family as easily as they would check out a book.

Informal education requires outreach programs, in partnership with local communities, to make contact with individuals where they live and work, regarding issues that affect how they live and work, in a style that speaks to them. Local organizations, including youth, senior, and other community groups, can play a pivotal role. They possess knowledge of the community and experience implementing various strategies to reach desired outcomes. While federal agencies, state governments, and nongovernmental groups do partner with communities on such programs, and should continue to promote participation of traditionally underrepresented and underserved groups, increasing populations and limited resources swamp the ability of these programs to reach all who would benefit from ocean-related information.

Information supplied to the public should be timely and accurate. It should also be supported by a system that allows for follow-up and the acquisition of additional information or guidance. The roles of, and relationships among, scientists, educators, and journalists in translating research results for the public are especially critical. Innovative partnerships with media outlets or industries that deal with the public may offer new means to broaden the visibility of ocean issues and increase public awareness. Informal education facilities and the academic community should work closely together to facilitate the rapid transfer and translation of the latest scientific discoveries into publicly accessible displays, materials, and programs.

Information delivered through informal education programs, displays, and activities is most effective when it is linked to the positive associations people have with the oceans. Information should be presented in terms of the ocean's role in the Earth system as a whole, including the physical, chemical, and geological aspects of the marine environment, and interactions with humans.

Recommendation 8–16. Ocean.ED, working with other appropriate entities, should enhance existing and establish new mechanisms for developing and delivering relevant, accessible information and outreach programs to enhance community education.

In addition, Ocean.ED should:

- *work with ocean-related informal education initiatives to better engage underrepresented and underserved populations and communities by using mechanisms, materials, and language familiar to and accepted by them.*
- *work with informal education facilities to develop the capacity to prepare and deliver new science-based materials and programs to the public and the media in a matter of weeks to capture immediate interest in noteworthy advances in ocean science.*

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U.S. COMMISSION ON OCEAN POLICY

PART IV
LIVING ON THE EDGE: ECONOMIC GROWTH AND CONSERVATION ALONG THE COAST

Chapter 9: Managing Coasts and their Watersheds

The pressures of continuing growth are acutely felt in coastal areas. While largely attributable to activities taking place at the coast, some pressures originate hundreds of miles away in inland watersheds. To more effectively manage coasts, states need a stronger capacity to plan for and guide growth—one that incorporates a watershed approach to govern coastal and ocean resources. In addition, to assist states in such development and support the move toward an ecosystem-based management approach, federal area-based coastal programs should be consolidated to better integrate and capitalize on the strengths of each. Finally, to reach the goal of economically and environmentally sustainable development, changes should be made to federal programs that currently encourage inappropriate growth in fragile or hazard-prone areas.

Attracting Crowds, Creating Opportunities

People, Jobs, and Opportunities

While coastal counties (located entirely or partially within coastal watersheds) comprise only 17 percent of the land area in the contiguous United States, they are home to more than 53 percent of the total U.S. population. A study of coastal population trends predicts average increases of 3,600 people a day moving to coastal counties, reaching a total population of 165 million by 2015.[1] These figures do not include the 180 million people who visit the coast every year.[2]

Population growth and tourism bring many benefits to coastal communities, including new jobs and businesses and enhanced educational opportunities. Burgeoning industries associated with tourism and recreation in coastal areas (such as hotels, resorts, restaurants, fishing and dive stores, vacation housing, marinas, and other retail businesses) have created one of the nation's largest and fastest-growing economic forces (Appendix C).

Coastal Activities Are Big Business

Across the country, more than 89 million people a year participate in marine-related recreation, such as swimming, scuba diving, surfing, motor boating, sailing, kayaking, and wildlife viewing.[3] In just four South Florida coastal counties, recreational diving, fishing, and ocean-watching activities generate $4.4 billion in local sales and almost $2 billion in local income annually[4] and more than 2.9 million people visit the Florida Keys each year.[5] During the summer of 2000, beach activities in Los Angeles and Orange counties stimulated an estimated $1 billion in spending.[6] The Hawaiian Islands and many U.S. island territories are particularly dependent on tourism for their economic health. Hawaii alone attracts some 7 million tourists each year.[7] In 2001, over 8 million people took to the sea aboard cruise ships, and approximately 135 million people visited the nation's marine aquariums and zoos.[8,9] Although golf and tennis are recognized as major U.S. industries, it is estimated that more Americans participate in recreational fishing than in both of these sports combined.[10]

Implications of Growth

The popularity of ocean and coastal areas increases pressures on these environments, creating a number of challenges for managers and decision makers. Increased development puts more people and property at risk from coastal hazards (Chapter 10), reduces and fragments fish and wildlife habitat (Chapter 11), alters sedimentation rates and flows (Chapter 12), and contributes to coastal water pollution (Chapter 14).

The rise in privately owned coastal land, coupled with the need to protect sensitive habitats, makes it increasingly difficult to provide public access to the shore. Every year, millions of dollars are spent replenishing sand at the nation's beaches and protecting coastal development from storms, waves, and erosion. And continued coastal development, coupled with rising sea level, results in ever-increasing wetlands losses.

Polluted waters limit fishing, swimming, and other water-related recreational and economic activities. One of the most serious impacts on ocean and coastal areas is the increasing amount of polluted runoff from urban, suburban, and agricultural areas, which is exacerbated by increases in impervious surfaces, such as roads, parking lots, sidewalks, and rooftops. Evidence indicates that ecosystem health is seriously impaired when the impervious area in a watershed reaches 10 percent. If current coastal growth trends continue, many healthy watersheds will cross the 10 percent threshold over the next twenty-five years.[11]

Although the rate of population growth in coastal counties is not greater than in other areas of the country, the sheer numbers of people being added to fixed coastal land areas, combined with the fragile nature of coastal resources, create disproportionate impacts (Appendix C). In many cases, these impacts are destroying the very qualities that draw people to the coast.

The pattern of coastal growth—often in scattered and unplanned clusters of homes and businesses—is also significant. Urban sprawl increases the need for infrastructure such as roads, bridges, and sewers, degrading the coastal environment while making fragile or hazard-prone areas ever more accessible to development. Because of the connections between coastal and upland areas, development and sprawl that occur deep within the nation's watersheds also affect coastal resources.

Strengthening Coastal Planning and Management

Multi-layered Decision Making

A complex combination of individuals and institutions at all levels of government make decisions that cumulatively affect the nation's ocean and coastal areas. These institutional processes determine where to build infrastructure, encourage commerce, extract natural resources, dispose of wastes, and protect or restore environmental attributes.

Many of the decisions that affect the nation's coastal areas are made by local governments through land use planning, zoning, subdivision controls, and capital improvement plans. Local decisions are shaped in turn by state policies and requirements. Some coastal states have developed statewide goals and policies for transportation, land use, and natural resource protection, with a few states putting specific emphasis on coastal resources. Recognizing that sprawling patterns of growth are not sustainable, several coastal states have instituted programs intended to manage growth, including Maine, Oregon, Florida, Washington, and Maryland. By applying a variety of land use planning tools, techniques, and strategies, these programs attempt to steer population growth toward existing population centers and away from fragile natural areas.

The Smart Growth Movement

For more than a decade, there has been a call for smart growth, characterized by more compact, land-conserving patterns of growth, through infill and reuse of building sites, pedestrian-friendly and transit-oriented development, and protection of green space. For example, in 1997, Maryland instituted its Smart Growth and Neighborhood Conservation Initiative, which tried to direct growth to more environmentally suitable areas and away from some of the state's most ecologically and economically important landscapes. Under this initiative, state agencies limited funding for infrastructure outside of designated growth areas. The Maryland experience, which has since been scaled back under new budgetary pressures, provides one model of growth management for consideration by other state and local governments.

Existing federal, state, and local institutional processes have made substantial progress in managing activities that affect the nation's coastal resources. However, local and state governments continue to face a number of obstacles in planning and managing the cumulative impacts of growth, including: disincentives to long-term planning due to the pressures of short political and business cycles; lack of shared values or political will; inadequate information, including locally relevant socioeconomic indicators; difficulty in addressing problems that cross multiple jurisdictions including upland areas; insufficient resources dedicated to protecting coastal resources; and multiple institutions at different levels of government that address isolated aspects of connected problems. Improved policies for managing growth in coastal areas will be essential in protecting and restoring the natural resources that sustain the character and economies of coastal communities.

Although most coastal management activities take place at state and local levels, coastal decision-making is also influenced by federal actions, including funding decisions and standard setting. Of the many federal programs that provide guidance and support for state and local decision-making, some address the management of activities and resources within designated geographic areas, while others address the management of specific resources, such as fisheries or marine mammals.

Federal Area-based Coastal Programs

The major area-based coastal programs include the Coastal Zone Management Program, National Estuarine Research Reserve System, and National Marine Sanctuaries Program of the National Oceanic and Atmospheric Administration (NOAA); the National Estuary Program of the U.S. Environmental Protection Agency (EPA); and the Coastal Program and Coastal Barrier Resources System of the U.S. Fish and Wildlife Service (USFWS). (These programs and others are also summarized in Appendix D.) In addition to their shared geographic focus, these programs are all implemented at the state and local level and highlight the importance of science, research, education, and outreach in improving the stewardship of ocean and coastal environments.

Coastal Zone Management Program

The Stratton Commission's 1969 report called for a national program to address development and environmental issues in coastal areas and to enhance the capacity of state and local governments to manage activities that affect these areas.[12] Three years after that report's release, Congress enacted the Coastal Zone Management Act (CZMA), the federal government's principal tool for fostering comprehensive coastal management. The CZMA created the Coastal Zone Management Program, a unique partnership between the federal and coastal state governments, whose goal is to balance the conservation of the coastal environment with the responsible development of economic and cultural interests.

Administered by NOAA, the CZMA provides two incentives for coastal states to voluntarily develop and conduct coastal management programs: federal grants and federal consistency authority. Federal consistency provisions require federal activities affecting land, water, or natural resources of a state's coastal zone to be consistent with the enforceable policies specified in that state's approved coastal management program.

Currently, thirty-four of thirty-five coastal states and territories have coastal programs in place, covering 99 percent of the nation's marine and Great Lakes coastlines. The tools, assistance, and resources provided by the CZMA have enabled states and territories to increase their management capacity and improve decision making to enhance the condition of their coastal areas. These programs facilitate public access to ocean and coastal areas, protect people and property from coastal hazards, conserve critical natural resources and stimulate economic development by revitalizing urban waterfronts and promoting coastal-dependent industries. The CZMA has also enhanced communication and coordination between federal and state governments and between state and local governments.

Under the CZMA, participating states are given the flexibility to design coastal management programs that address their individual priorities and the programs are approved as long as they meet certain minimum national guidelines. This flexibility has been hailed by many as the CZMA's greatest virtue and by others as its most serious shortcoming.

State-by-state implementation has resulted in wide variations in the strength and scope of state coastal management programs. NOAA has few options to ensure that the programs are meeting national guidelines other than withholding funding or withdrawing program approval. No state program has ever been disapproved. The geographic boundaries of state coastal management programs also differ greatly. The CZMA defines the coastal zone—the area subject to the enforceable policies of a state's program—as stretching from the seaward boundary of state ocean waters (generally 3 nautical miles) to the inland extent deemed necessary by each state to manage activities that affect its coastal resources. Individual state discretion regarding the landward reach of its coastal zone has resulted in major variations. For example, Florida, Delaware, Rhode Island, and Hawaii include the entire state in their coastal zones, while the inland boundary of California's coastal management program varies from a few hundred feet in urban areas to several miles in rural locales.

The Coastal Zone Management Program can be strengthened by developing strong, specific, measurable goals and performance standards that reflect a growing understanding of the ocean and coastal environments, the basic tenets of ecosystem-based management, and the need to manage growth in regions under pressure from coastal development. A large portion of federal funding should be linked to program performance with additional incentives offered to states that perform exceptionally well. In addition, a fallback mechanism is needed to ensure that national goals are realized when a state does not adequately participate or perform.

The landside boundaries of state coastal management programs should also be reconsidered. At a minimum, each state should set the inland extent of its coastal zone based on the boundaries of coastal watersheds (discussed in Chapter 1). In creating new management areas, state programs should consider additional factors such as large or growing population centers, areas of considerable land use, and particularly sensitive natural resources, such as wetlands. Social and natural resource assessment and planning at the watershed scale should become a high priority in each state's program.

What Is a Coastal Watershed?

Everyone in the United States lives in a watershed. A watershed is a geographic area in which water flows on its way to a larger water body, such as a stream, river, estuary, lake, or ocean. The nation's coastal and ocean resources are affected not only by activities in coastal areas but also by those in upland watersheds.

A coastal watershed, as defined by the National Oceanic and Atmospheric Administration, is that portion of a watershed that includes the upstream extent of tidal influence. In the Great Lakes region, a coastal watershed includes the entire geographic area that drains into one of the lakes.[13]

Funding for CZMA implementation remains a significant concern, having been capped at $2 million per coastal state since 1992. This level hampers program implementation and should be considerably increased to enable states to effectively carry out important existing and planned program functions, including the inclusion of coastal watersheds.

Recommendation 9-1. Congress should reauthorize the Coastal Zone Management Act (CZMA) to strengthen the planning and coordination capabilities of coastal states and enable them to incorporate a coastal watershed focus and more effectively manage growth. Amendments should include requirements for resource assessments, the development of measurable goals and performance measures, improved program evaluations, additional funding to adequately achieve the goals of the Act, incentives for good performance and disincentives for inaction, and expanded boundaries that include coastal watersheds.

Specifically, CZMA amendments should address the following issues:

- ***resource assessments–****State coastal management programs should provide for comprehensive periodic assessments of the state's natural, cultural, and economic coastal resources. These assessments will be critical in the development of broader regional ecosystem assessments, as recommended in Chapter 5.*
- ***goals—****State coastal management programs should develop measurable goals based on coastal resource assessments that are consistent with national and regional goals. State coastal programs should work with local governments, watershed groups, nongovernmental organizations, and other regional entities, including regional ocean councils, to develop these goals.*
- ***performance measures—****State coastal management programs should develop performance measures to monitor their progress toward achieving national, regional, and state goals.*
- ***evaluations—****State coastal management programs should continue to undergo periodic performance evaluations by the National Oceanic and Atmospheric Administration. In addition to the existing evaluation criteria, the performance measures developed by state programs should also be reviewed. The public, representatives of watershed groups, and applicable federal program representatives should participate in these program evaluations.*
- ***incentives—****Existing incentives for state participation—federal funding and federal consistency authority—should remain, but a substantial portion of the federal funding received by each state should be based on performance. Incentives should be offered to reward exceptional accomplishments, and disincentives should be applied to state coastal management programs that are not making satisfactory progress in achieving program goals.*
- ***boundaries—****Coastal states should extend the landward side of their coastal zone boundaries to encompass coastal watersheds. Mechanisms should also be established for coordinating with watershed management groups outside of a state's designated coastal zone boundary.*

Coastal Barrier Resources System

The Coastal Barrier Resources Act established the Coastal Barrier Resources System in 1982 to promote coastal conservation on barrier islands and minimize the loss of human life and property from coastal hazards. Through this program, which is administered by USFWS, the federal government discourages development on designated barrier islands in the Atlantic and Gulf coasts, Puerto Rico, the U.S. Virgin Islands, and the Great Lakes by restricting certain federal assistance, including flood insurance coverage, loans, funding for U.S. Army Corps of Engineers development projects, and construction of sewer systems, water supply systems, and transportation infrastructure. Nearly 1.3 million acres of land along the East Coast, Great Lakes, and Gulf of Mexico are part of the system. The program does not ban all development in these areas; rather, it creates disincentives by denying federal subsidies and imposing the full costs of development on the developer or property owner.

National Estuarine Research Reserve System

The CZMA established the National Estuarine Sanctuaries Program in 1972 for the purpose of creating "natural field laboratories in which to study and gather data on the natural and human processes occurring within the estuaries of the coastal zone." That program evolved into NOAA's National Estuarine Research Reserve System (NERRS), which provides funds to states for acquiring estuarine areas and developing and operating research facilities and educational programs. The NERRS program currently includes twenty-five reserves in twenty-one states.

National Marine Sanctuary Program

In 1972, one hundred years after the first national park was created, a similar commitment was made to preserving marine treasures by establishing the National Marine Sanctuary Program within NOAA. Since then, thirteen national marine sanctuaries have been designated, representing a variety of ocean environments. The mission of the program is to serve as the trustee for these areas and to conserve, protect, and enhance their biodiversity, ecological integrity, and cultural legacy. Sanctuaries are designated for many objectives, ranging from protecting the breeding and calving grounds of humpback whales to preserving the remains of historic shipwrecks.

National Estuary Program

Created by the 1987 amendments to the Clean Water Act, the National Estuary Program (NEP) was established to improve the quality of estuaries of national importance. EPA administers the program, and provides funds and technical assistance to local stakeholders to develop plans for attaining or maintaining water quality in designated estuaries. The program requires stakeholders to develop a comprehensive conservation and management plan that includes measures for protection of public water supplies, protection and propagation of fish, shellfish, and wildlife populations, allowance for recreational activities in and on the water, and control of point and nonpoint sources of pollution that supplements existing pollution control measures. Currently, twenty-eight estuaries are included in the program. In several cases, more than one state participates in a single NEP. In contrast to the CZMA's broad scope and focus on state and local government decisions throughout the coastal zone, the NEP concentrates on bringing together stakeholders in particular areas that are in or approaching a crisis situation.

The assessment and planning process used by the NEP holds promise for the future of ecosystem-based management. However, the lack of federal funding and assistance for the implementation of NEP plans limits their effectiveness, as do the intergovernmental obstacles that arise when an estuary spans multiple states.

Coastal Program of the U.S. Fish and Wildlife Service

Through its Coastal Program, the USFWS undertakes habitat conservation efforts in bays, estuaries, and watersheds along the U.S. coastline, including the Great Lakes. The program targets funding to sixteen high-priority coastal ecosystems, providing assessment and planning tools to identify priority sites for protection and restoration, conserving pristine coastal habitats through voluntary conservation easements and locally initiated land acquisition, and forming partnerships to restore degraded habitat.

Linking Area-based Programs

The area-based programs described above have made significant progress in managing coastal resources in particular locations, working with communities and decision makers in those areas, and fostering improved coordination between different levels of government. However, because these programs generally operate in isolation from one another, they cannot ensure effective management of all ocean and coastal resources or achievement of broad national goals. As NOAA is strengthened through the multi-phased approach described in Chapter 7, consolidation of area-based coastal resource management programs will result in more effective, unified strategies for managing these areas, an improved understanding of the ocean and coastal environment, and a basis for moving toward an ecosystem-based management approach.

Recommendation 9-2. Congress should consolidate area-based coastal management programs in a strengthened National Oceanic and Atmospheric Administration (NOAA), capitalizing on the strengths of each program. At a minimum, this consolidation should include the Coastal Zone Management, National Estuarine Research Reserve System, and National Marine Sanctuary programs currently administered by NOAA and additional programs administered by other agencies: the Coastal Barrier Resources System; the National Estuary Program; and the U.S. Fish and Wildlife Service Coastal Program.

Other Relevant Federal Programs

In addition to the area-based programs discussed above, a number of other laws significantly affect coastal resources, including the National Environmental Policy Act, Clean Water Act, and Clean Air Act. Programs related to transportation, flood insurance, disaster relief, wetlands permitting, dredging, beach nourishment, shoreline protection, and taxation also exert a profound influence on the coast. While these laws and policies address specific issues, and have each provided societal benefits, in many cases federal activities under their purview have inadvertently led to degradation of coastal environments. For example, road construction can have negative impacts on coastal areas and resources—including habitat destruction, increased runoff, and encouragement of inappropriate development—that could be mitigated if transportation infrastructure activities were implemented in the context of comprehensive, ecosystem-based goals and plans.

Regional coordination of federal agency activities, as recommended in Chapter 4, along with establishment of regional ocean councils and regional ocean information programs, as recommended in Chapter 5, would greatly improve federal project planning and implementation. Enhancing the relationships between federal agencies, state coastal resource managers, and all decision makers would also help to ensure compatibility among the many activities that affect ocean and coastal environments.

Recommendation 9–3. The National Ocean Council should recommend changes to federal funding and infrastructure programs to discourage inappropriate growth in fragile or hazard-prone coastal areas and ensure consistency with national, regional, and state goals aimed at achieving economically and environmentally sustainable development.

Examples of programs to be reviewed include:

- *Federal Emergency Management Agency hazards-related programs that may encourage development in high-hazard, flood, and erosion areas (see Chapter 10).*
- *U.S. Army Corps of Engineers wetland permitting, dredging, beach nourishment, and shoreline protection programs (see Chapters 11 and 12).*

Linking Coastal and Watershed Management

In recent years there has been a growing interest in watershed management. This approach addresses water quality and quantity issues by acknowledging the hydrologic connections between upstream and downstream areas and considering the cumulative impacts of all activities that take place throughout a watershed.

The environmental and political characteristics of the nation's watersheds vary tremendously. As a result, watershed management initiatives can differ widely in size and scope. Many watershed groups are formed at the local level by community members concerned about water quality or the health of fish and wildlife populations. Often, these groups work to improve watershed health through partnerships among citizens, industry, interest groups, and government.

The value of a watershed approach was articulated by the National Research Council in a 1999 report: "[w]atersheds as geographic areas are optimal organizing units for dealing with the management of water and closely related resources, but the natural boundaries of watersheds rarely coincide with political jurisdictions and thus they are less useful for political, institutional, and funding purposes. Initiatives and organizations directed at watershed management should be flexible to reflect the reality of these situations."[14]

The benefits of a watershed focus have been recognized at state, regional, national, and international levels. For example, Oregon has defined watershed groups in law, and has also created a process for their legal recognition and funding. The New Jersey government includes a Division of Watershed Management that provides coordinated technical, financial, and planning support for twenty watershed management areas within the state. New Jersey also participates, along with Pennsylvania, Delaware, and New York, in the Delaware River Basin Commission—a regional body authorized to manage activities within a river system that transcends political boundaries. The Chesapeake Bay Program, the California Bay-Delta Program (known as CALFED), and the Northwest Power Planning Council are other notable examples of current initiatives that aim to address natural resource issues on a watershed scale. Some existing bi-national watershed initiatives include the Great Lakes Commission, Shared Strategy for Puget Sound, and the Gulf of Maine Council on the Marine Environment. Federal agencies have also begun to adopt a watershed management focus. For example, beginning in the 1990s, EPA launched efforts to address certain problems at the watershed level, rather than on a source-by-source or pollutant-by-pollutant basis.

As interest in watershed management continues to grow, so does the need for a framework to guide such initiatives and evaluate their effectiveness. The federal government can play an important role by helping to develop a framework and by providing technical and financial assistance to states and communities for watershed initiatives.

Recommendation 9–4. Congress should amend the Coastal Zone Management Act, the Clean Water Act, and other federal laws where appropriate, to provide better financial, technical, and institutional support for watershed initiatives. Amendments should include appropriate incentives and flexibility for local variability. The National Ocean Council should develop guidance concerning the purposes, structures, stakeholder composition, and performance of such initiatives.

Linking Coastal and Offshore Management

As discussed in Chapter 6, the growing number of activities that take place in offshore waters calls for a more comprehensive offshore management regime. While the focus of this chapter is on coastal and watershed management, it is important to recognize the strong relationship between the management of onshore and offshore resources. States have long asserted their interests offshore, both by acting as the trustee for public resources in and beneath state waters, and by exerting their responsibilities (principally through the CZMA federal consistency provisions, described on the next page) for activities that take place in federal waters but affect state resources. Several states, including Oregon, California, and Hawaii, have developed comprehensive plans to guide ocean activities, resolve conflicts, and anticipate new uses in their waters. Other states, including Florida, Maine, Mississippi, and North Carolina have conducted extensive studies of ocean issues affecting their states. In 2003, Massachusetts launched a specific ocean planning initiative.

Balancing Federal Ocean Activities with State Coastal Management Programs: The Federal Consistency Tool

In the area of natural resource management, one of the more interesting, innovative, and sometimes contentious features of the nation's system of federalism is the relationship between the federal government and coastal state governments with respect to the control and shaping of ocean activities in federal waters.

Historically, this relationship has taken on many hues and forms, but its policy and legal aspects have been largely structured over the last three decades by the development of one section of a single law, the so-called federal consistency provision (Section 307 of the Coastal Zone Management Act (CZMA)). As noted earlier in this chapter, the promise of federal consistency was one of two incentives (the other being grant money) Congress provided to encourage state participation in this voluntary program.

In very general terms, it is a promise that federal government actions that are reasonably likely to affect the coastal resources of a state with an approved coastal management program will be consistent with the enforceable policies of that program. Essentially, under some circumstances, it is a limited waiver of federal authority in an area—offshore waters seaward of state submerged lands—in which the federal government otherwise exercises full jurisdiction over the management of living and nonliving resources.

The underlying principle of federal consistency represents a key feature of cooperative federalism: the need for federal agencies to adequately consider coastal state coastal management programs by fostering early consultation, cooperation, and coordination before taking an action that is likely to affect the land or water use or natural resources of such state's coastal zone. It facilitates significant input at the state and local level from those who are closest to the issue and in a position to know the most about their coastal resources.

The process, however, is not one-sided. For states to exercise federal consistency authority, they must submit and receive approval of their coastal management programs from NOAA. Congress established the general criteria for approval of the programs, including a review by other federal agencies before the plans are officially authorized. A core criterion for program approval is whether the management program adequately considers the national interest when planning for and managing the coastal zone, including the siting of facilities (such as energy facilities) that are of greater than local significance.

Once a state has received approval, federal consistency procedures are triggered. Under current practice, states only review federal actions that have reasonably foreseeable coastal effects. There is flexibility in the law to allow agreements between states and federal agencies that can streamline many aspects of program implementation. For example, there may be understandings with respect to classes of activities that do not have coastal effects. Otherwise, the decisions about such effects are made on a case-by-case basis.

There have been disagreements between federal agencies and states on some coastal issues, the more high profile ones largely in the area of offshore oil and gas development (Chapter 24). Nevertheless, in general, the federal consistency coordination process has improved federal-state relationships in ocean management. States and local governments have to consider national interests while making their coastal management decisions and federal agencies are directed to adjust their decision-making to address the enforceable policies of a state's coastal management program.

In the event of a disagreement between the state and a federal agency, the agency may proceed with its activity over the state's objection, but it must show that it is meeting a certain level of consistency. In a separate part of the federal consistency section, the coastal activities of third party applicants for federal licenses or permits are required to be consistent with the state's program. If the state does not certify that the activities will be consistent, the federal agency shall not grant the license or permit and the proposed action may not go forward. An applicant can appeal such a decision to the Secretary of Commerce, who has certain specified grounds on which he or she can overturn the state's finding of inconsistency.

Today, after some thirty years of evolution in the practice and implementation of this rather unusual intergovernmental process, federal agencies do not take the consistency standard lightly, as it is a fairly high threshold to meet. The result, according to NOAA, has been an outstanding level of cooperation and negotiation between states and federal agencies[15] such that approximately 93-95 percent of the activities are approved.[16]

INCREASING UNDERSTANDING OF COASTAL ECOSYSTEMS

To improve the management of the nation's oceans and coasts, decision makers at all levels will need to gain a better understanding of ecosystems, both how they function and how human activities and natural events affect them. The creation of regional ocean information programs, as recommended in Chapter 5, is one important vehicle for enabling decision makers to better communicate their information needs to the scientific community, and ensuring that new information is converted into useful products. Coastal and watershed management activities, and growing efforts to link these two approaches, should provide the information necessary for the public to be responsible stewards of the nation's oceans, coasts, and watersheds.

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CHAPTER 10:
GUARDING PEOPLE AND PROPERTY AGAINST NATURAL HAZARDS

Rising populations and poorly planned development in coastal areas are increasing the vulnerability of people and property to storms, hurricanes, flooding, shore erosion, tornadoes, tsunamis, earthquakes, and sea level rise. To lessen the threat from natural hazards, the federal government should coordinate the efforts of all coastal management agencies to reduce inappropriate incentives created by federal infrastructure investments. It should also improve a number of natural hazards-related activities implemented by the Federal Emergency Management Agency, including hazards information collection and dissemination, the National Flood Insurance Program, and hazards mitigation planning.

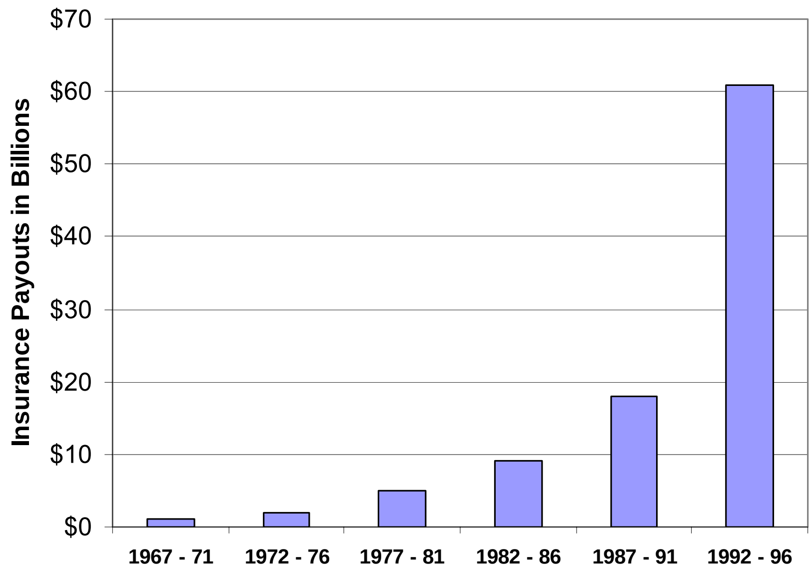
ASSESSING THE GROWING COST OF NATURAL HAZARDS

The nation has experienced enormous and growing losses from natural hazards. Conservative estimates, including only direct costs such as those for structural replacement and repair, put the nationwide losses from all natural hazards at more than $50 billion a year, though some experts believe this figure represents only half or less of the true costs.[1] More accurate figures for national losses due to natural hazards are unavailable because the United States does not consistently collect and compile such data, let alone focus on specific losses in coastal areas. Additionally, there are no estimates of the costs associated with destruction of natural environments. Between 1967 and 1996, insurance payouts (which cover only a small portion of losses) rose steadily from $1 billion between 1967 and 1971, to $61 billion between 1992 and 1996, roughly doubling every five years (Figure 10.1).[2] While stricter building codes, improved forecasts, and early warning systems have helped save lives, deaths from natural hazards are expected to rise along with development and population along the nation's coasts.[3]

Hurricanes Wreak Havoc along the Coast

In 1989, Hurricane Hugo hit the U.S. Virgin Islands and Puerto Rico before coming ashore at Charleston, South Carolina, causing twenty-six deaths in the United States and an estimated $9.7 billion in damages. Just three years later, in 1992, Hurricane Andrew struck southern Florida and Louisiana, causing twenty-three deaths directly and dozens more indirectly. Andrew wrought an estimated $35 billion in damages, making it the costliest hurricane in U.S. history. And in 1999, Hurricane Floyd, the deadliest of recent hurricanes, made landfall along the Mid-Atlantic and northeastern United States, causing fifty-six deaths and an estimated $4.6 billion in damage. (All figures adjusted to 2000 dollars.)[4]

Figure 10.1. The Growing Cost of Natural Disasters



In the thirty years between 1967 and 1996, insurance companies have experienced a 6,000 percent increase in payouts to federal and private insurance holders for damages due to natural catastrophes.
Source: Consumer Federation of America. *America's Disastrous Disaster System*. Washington, DC, January, 1998.

Improving Federal Management of Hazards in Coastal Areas

Many federal agencies have explicit operational responsibilities related to hazards management, while numerous others provide technical information or deliver disaster assistance. The nation's lead agencies for disaster response, recovery, mitigation, and planning are the Federal Emergency Management Agency (FEMA) and the U.S. Army Corps of Engineers (USACE). These agencies implement programs that specifically target the reduction of risks from natural hazards. The National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish and Wildlife Service (USFWS) also have a significant influence on natural hazards management.

NOAA's weather forecasting and ocean observing functions are vital to hazards management. NOAA's National Weather Service plays a key role in collecting atmospheric weather and oceanic real-time data for management, assessments, and predictions. Through its implementation of the Coastal Zone Management Act, the agency also plays a notable role in discouraging coastal development in areas at risk from natural hazards. (Additional discussion of these roles, and recommendations for enhancing NOAA's contributions, are found in Chapters 9 and 26.) The Coastal Barrier Resources Act administered by USFWS (Chapter 9), also has significant implications for natural hazards management.

This chapter focuses on those federal programs that specifically target the reduction of losses of life and property due to natural hazards along the nation's coasts. Among the opportunities for improving federal natural hazards management, four stand out: amending federal infrastructure policies that encourage inappropriate development; augmenting hazards information collection and dissemination; improving the National Flood Insurance Program (NFIP); and undertaking effective and universal hazards mitigation planning.

Changing Inappropriate Federal Incentives

The federal government has made substantial investments in infrastructure designed to reduce human exposure to hazards, including flood control and coastal erosion projects. These efforts often eliminate or conflict with the natural buffers that would otherwise help shield communities. Furthermore, because such projects are not accompanied by strict restrictions on subsequent construction, they may actually encourage further commercial and residential development in hazard-prone areas. In some cases, a federal infrastructure project intended to reduce a hazard merely drives the problem to a nearby location, such as when erosion control efforts lead to further coastal armoring up or down the coast. The cumulative impact of such projects may be weakening the ecosystem's natural resilience to hazards and creating the potential for even greater losses to property, health, and natural resources.

Of course, the federal government is not the sole driver of infrastructure development in coastal areas. State and local governments also build roads and bridges along and over the water, underwrite wastewater treatment, and support water supply projects, all of which have impacts on coastal development and vulnerability.

The great majority of federal infrastructure programs are implemented by USACE, whose hazards-related activities include flood control efforts such as dams, dikes, and levees, and coastal erosion projects such as groins, sea walls, revetments, and beach nourishment. USACE also has responsibilities for dealing with disaster response efforts such as construction of emergency infrastructure.

New Orleans at Risk

Prior to 1965, New Orleans—a community that sits as much as 10 feet below sea level—had suffered substantial losses of protective barrier islands and wetlands and developed an elaborate system of flood control measures. After Hurricane Betsy struck in 1965, causing $1 billion in damages,[5] hundreds of millions of dollars were spent to upgrade the flood control system that now includes more than 520 miles of levees, 270 floodgates, 92 pumping stations, and thousands of miles of drainage canals.

While the new protections did reduce risks to people and property in developed areas, they also encouraged additional development in flood-prone regions.[6] New Orleans Parish and the adjoining suburban Jefferson Parish ranked first and second among communities receiving repeat payments for damage claims under the National Flood Insurance Program between 1978 and 1995. These two communities alone accounted for 20 percent of the properties with repeat losses, at an average of nearly three claims per property, for a total of $308 million in claims.[7]

New Orleans' protective levees are designed to withstand only a moderate (category three) hurricane storm surge. Were they to fail, the city and surrounding areas could suffer upward of $25 billion in property losses and 25,000–100,000 deaths by drowning.[8, 9]

Evolving public values that favor environmental protection, as well as a growing understanding of the complex workings of natural systems, have propelled USACE to adopt more environmentally conscious initiatives, including the pursuit of nonstructural approaches to some flood control projects. However, such initiatives are not universally embraced within the agency, by all stakeholders, or in Congress, and remain greatly outnumbered by traditional, engineering-oriented USACE projects that may disrupt natural hydrological and geomorphological processes, harm ecosystems, and create incentives for additional human development in high-risk regions.

USACE has also been the focus of debates about the cost-benefit analyses used to review proposed projects. Some experts have suggested that these analyses are often flawed by a reliance on incorrect assumptions and faulty methodologies. In 2001, the National Research Council (NRC) began a comprehensive review of USACE programs and procedures. A 2002 NRC report recommended external review of all controversial or complex USACE civil works projects.[10]

Recommendation 10–1. The National Ocean Council should review and recommend changes to the U.S. Army Corps of Engineers' Civil Works Program to ensure valid, peer-reviewed cost-benefit analyses of coastal projects, provide greater transparency to the public, enforce requirements for mitigating the impacts of coastal projects, and coordinate such projects with broader coastal planning efforts.

Improving Understanding

The federal government plays an important role in acquiring complex hazards-related data and translating them into information that states and communities can use to reduce their vulnerability to natural disasters. A number of federal agencies and departments, including NOAA, the U.S. Geological Survey, the National Aeronautics and Space Administration, and the U.S. Department of Defense, are charged with increasing both basic understanding and site-specific knowledge about natural hazards. These agencies' principal contributions include: developing and deploying new technologies for understanding land, ocean, and atmospheric processes and their interactions; tracking and predicting hazards, especially meteorological hazards; assessing hazards risks; conducting post-disaster research; and communicating this information to end users. These contributions have significantly improved the quality and timeliness of weather-related warnings, increasing the lead time for protective measures and evacuations. Implementation of the Integrated Ocean Observing System (discussed in Chapter 26) would improve weather-related warnings and provide additional predictive capabilities for tsunamis and for chemical and biological hazards, such as sudden pollutant loadings, harmful algal blooms, and pathogens.

FEMA, as the lead disaster management agency, collects, analyzes, and disseminates hazards-related data as well as assesses the effectiveness of its programs. However, these efforts fall short of shaping an effective overall national policy and providing the information state and local decision makers and individuals need to fully understand their risks from coastal hazards. The absence of a standard, centralized data collection system that could produce accurate accounting for losses from natural hazards is only one example. An inability to provide adequate, useful information at the local, state, and regional levels can lead to incorrect estimates of risk, which then affect cost-benefit analyses of proposed development and mitigation projects. Local land use decisions are frequently made without information about cumulative impacts or the vulnerability of individuals and groups in the community, and without an ability to judge the full impact of disasters on humans, institutions, the economy, natural resources, and ecosystem services. This lack of accurate information is likely to reinforce the tendency to underestimate risks from natural hazards and delay taking action to prevent future problems. These concerns are documented in a 2000 report issued by the H. John Heinz III Center for Science, Economics and the Environment, *The Hidden Costs of Coastal Hazards*.

Flooding is the most costly of natural hazards, and maps produced by the National Flood Insurance Program are the federal government's primary tool for communicating flood risks to communities and individuals.[11] Most existing flood hazard maps are not georeferenced, limiting their usefulness for hazards planning. (Chapter 25 includes a broader discussion of coastal mapping needs.)

The combination of mounting federal and nonfederal disaster expenses, vigorous advocacy by the insurance community, state and local governments, and others who rely on flood maps, and the incorporation of FEMA into the U.S. Department of Homeland Security spurred Congress to provide substantial financial support to an ambitious FEMA map modernization program beginning in fiscal year 2002. This effort will create a digital base map, update and digitize flood hazards information, and provide standard protocols that state and local governments and others can use to incorporate and relate information about other natural and manmade hazards. Though FEMA's map modernization effort is intended to target the highest-risk communities first, the initial selection made in 2003 did not include any coastal communities—despite their status as high-population, high-risk regions—because of technical difficulties in mapping coastal flood hazards. FEMA's plans call for updating priority coastal community maps starting in fiscal year 2004 when these obstacles are resolved.[12]

Although many communities are in a position to benefit from this opportunity, others may be constrained by a lack of technical and financial resources and expertise. National maps that reflect all hazards (for example, coastal erosion, localized stormwater drainage flooding, potential flood control structure failures, and increased risk from development, land subsidence, and sea level rise) are needed to communicate the true vulnerability of a community, its social and physical infrastructure, and the surrounding ecosystem. Such maps will also be essential in informing prospective purchasers of coastal property about potential hazards. FEMA and other relevant agencies will need to work together to make such comprehensive mapping a reality.

Recommendation 10–2. The National Ocean Council should establish a task force of appropriate federal agencies and representatives from state and local governments, with the Federal Emergency Management Agency in the lead, to improve the collection and usability of hazards-related data.

The hazards-related data task force should develop a coordinated effort that includes the following functions:

- *systematic collection, storage, analysis, and dissemination of data on post-disaster losses and the cost of mitigation efforts.*
- *development and transmittal to communities of the information and tools they need to understand the risks of hazards to their residents and their social, physical, economic, and environmental infrastructures.*
- *expansion of the federal government's mapping mandate beyond flood hazards to achieve—in partnership with state and local governments—comprehensive, digitized, georeferenced mapping and identification of all natural hazards.*
- *development of adequate funding proposals for the National Flood Insurance Program map modernization initiative, including a high-priority effort to update maps for high-risk coastal communities.*

The National Flood Insurance Program

Enacted in 1968, the National Flood Insurance Program (NFIP) is the federal government's primary tool for managing flood hazards through a combination of incentives and regulation. In addition to the development of maps identifying flood-prone areas, the NFIP provides (or helps private companies provide) flood insurance to owners of commercial and residential structures in communities that adopt appropriate construction standards. Premiums and fees from property owners cover most program costs. Other NFIP responsibilities include identifying flood hazards, assessing risks, and implementing measures for reducing losses. While the NFIP is a national program, the majority of its policies, total coverage, and premium revenues are associated with coastal communities.

Without the NFIP, many of the more than 19,000 participating communities most likely would not have had the incentive to develop active programs to manage flood risks. Unlike private-sector insurers, the federal government can carry debt over the long term and replenish funds depleted by catastrophic disasters over time. For this reason, the federal government is able to undertake the expense of mapping flood hazards nationally and subsidize coverage for older buildings. FEMA estimates that NFIP building standards and other floodplain management measures reduce flood losses by $1 billion per year.[13]

As impressive as these accomplishments are, concerns have been raised that the NFIP may inadvertently be facilitating inappropriate coastal development and redevelopment. While many factors weigh heavily in such decisions, including the market forces that make real estate in coastal floodplains and estuarine areas so valuable, the availability of flood insurance also plays a role. Determining the extent of this role is difficult because the impacts of the NFIP have never been comprehensively evaluated. FEMA recently commissioned such an evaluation, with several reports expected to be issued, including a final comprehensive report scheduled for September 2005. This study will help inform the National Ocean Council and determine any further action. Nonetheless, three aspects of the program—treatment of erosion hazards, coverage of repetitive losses, and availability of insurance in undeveloped floodplain and erosion zones—are issues that merit immediate attention.

Informing the Public about Erosion Risks

Property owners within 500 feet of the shoreline face as large a risk from erosion as from flooding. Under current conditions, approximately one-quarter of all homes within 500 feet of the coast will be lost to erosion in the next sixty years. Insurance rates in areas designated as coastal high-hazard zones would need to double over the next thirty to sixty years to keep pace with increasing erosion risks.[14] Although FEMA has developed a plan for undertaking erosion mapping and reflecting actual risks in future NFIP insurance rates, the agency is awaiting congressional authorization to implement the plan. If erosion mapping and rating are not carried out, higher rates will have to be spread across all policyholders, losing an important opportunity to discourage building in the riskiest areas.

Repetitive-loss Properties

The NFIP requires that substantially damaged properties be removed or elevated. However, local governments are responsible for determining whether a property is substantially damaged and they are often reluctant to do so when a property owner does not have the financial resources to move or elevate the home.[15] Absent this designation, many of these properties have been rebuilt in place, leading to repeated claims. Although only 2 percent of NFIP covered properties have received repetitive-loss payments, they account for 40 percent of overall NFIP payments, many at cumulative totals exceeding the property's value. Although repetitive losses occur around the country, between 1978 and 1995, Louisiana and Texas accounted for $1.1 billion, or 40 percent of the $2.75 billion in total repetitive-loss claims paid by the NFIP.[16]

Approximately 90 percent of repetitive-loss payments are for buildings that predate NFIP maps.[17] This demonstrates the effectiveness and success of NFIP building standards for new construction in flood-prone areas, but also underscores the program's lack of authority for reducing the vulnerability of older buildings. Many property owners underestimate their risk, resist investments in structural improvements that do not directly translate into higher home prices, and then rely on federal disaster assistance as a fallback when floods occur. For some properties, the most acceptable and economical solution for all concerned will be voluntary buyouts at prices that allow property owners to relocate out of harm's way.

Eliminating Incentives for Development in Floodplains and Eroding Areas

The NFIP was created both as a more desirable alternative to federal disaster relief in the wake of flooding and as a tool to guide development away from flood prone areas through state and local floodplain management. However, of the 6.6 million buildings located in the 100-year floodplains of participating communities, more than a third were built after the NFIP maps were created and floodplain management requirements imposed.[18] As one of the federal government's principal tools for influencing development in high-hazard areas, the NFIP's risk assessment, mitigation, and insurance components should be revamped to better achieve the original goal of discouraging communities from building in harm's way.

Recommendation 10–3. The National Ocean Council should recommend changes in the National Flood Insurance Program (NFIP) to reduce incentives for development in high-hazard areas.

Specifically, NFIP changes should:

- *establish clear disincentives to building or rebuilding in coastal high-hazard zones by requiring property owners at risk of erosion to pay actuarially sound rates for insurance.*
- *enforce measures that reduce vulnerability to natural hazards, including assistance in retrofitting older structures and buyout programs for susceptible structures with repetitive-loss histories.*
- *create enforceable mechanisms to direct development away from undeveloped floodplains and erosion zones.*

Hazards Mitigation Planning

Hazards mitigation planning—the process of assessing potential hazards and evaluating and identifying actions to reduce or eliminate vulnerabilities—has been required of states for nearly two decades as a condition of receiving disaster relief and other FEMA funding. However, the quality of those plans, and the degree to which they are based on a sound process with adequate stakeholder involvement, vary widely. Major disaster losses in the 1990s led FEMA to increase its attention to hazards mitigation planning, establishing a unit dedicated to that purpose in 1998.

Congress also recognized that deficiencies in mitigation planning prevented the most effective use of disaster assistance funds. Communities recovering from disasters receive little guidance during the rebuilding process to improve their resilience to future disasters. In the Disaster Mitigation Act, passed in 2000, Congress directed FEMA to impose more stringent mitigation planning requirements on states. States that fail to meet FEMA's new criteria can be denied disaster assistance and some other types of funding, while states that develop excellent mitigation plans are eligible to use a greater proportion of their disaster funding to implement further hazards mitigation projects.

Effective hazards mitigation planning is fully consistent with watershed and ecosystem-based management approaches because they all attempt to consider communities and the effects of human activities within the broader environmental context. Effective watershed management plans that include a hazards component can be used to satisfy FEMA's mitigation planning requirements. The agency has also expressed a goal of integrating sustainable redevelopment into its program, recognizing the interdependence among economic opportunity, community well-being, and protection of the natural environment.

In 2002, FEMA issued regulations implementing enhanced mitigation planning standards, with compliance required for most state and local governments by October 2004. However, many state and local governments are struggling to comply with the new criteria because of severe fiscal constraints, technical difficulties, and relatively low levels of federal support. In addition to providing greater technical and financial assistance, it may be appropriate to withhold other forms of hazards-related federal financial assistance until mitigation plans are in place. For example, the U.S. Small Business Administration has limited eligibility for its low-interest Pre-Disaster Mitigation Loan Program to communities with approved plans.

Recommendation 10–4. The National Ocean Council (NOC) should encourage Congress to increase financial and technical assistance to state and local entities for developing hazards mitigation plans consistent with requirements of the Federal Emergency Management Agency (FEMA). The NOC should also identify opportunities for conditioning federal hazards-related financial and infrastructure support on completion of FEMA-approved state and local hazards mitigation plans.

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Chapter 11: Conserving and Restoring Coastal Habitat

Wetlands, estuaries, seagrass beds, mudflats, sand beaches, mangrove forests, coral reefs… these are just some of the diverse habitats that make up the ocean and coastal environment and provide invaluable benefits to humans and marine life. Marine habitats face increasing pressures as activities within ocean and coastal areas intensify. Coastal habitat conservation and restoration should be integral to ocean and coastal management, as well as to the management of activities within watersheds, and should be strengthened through the development of national, regional, and local goals, the institution of a dedicated program for coastal and estuarine conservation, better coordination of federal habitat-related activities, and improved research, monitoring, and assessment.

Assessing the Threats to Coastal Habitat

The diverse habitats that comprise the ocean and coastal environment provide tangible benefits such as buffering coastal communities against the effects of storms, filtering pollutants from runoff, and providing a basis for booming recreation and tourism industries. These habitats also provide spawning grounds, nurseries, shelter, and food for marine life, including a disproportionate number of rare and endangered species.[1]

As more people come to the coast to live, work, and visit, coastal habitats face increasing pressures. Most human activities in coastal areas provide distinct societal benefits, such as dredging rivers and harbors to facilitate navigation, converting forests and wetlands for agriculture and development, and building dams for flood control and hydropower. But these activities can also degrade coastal habitats and compromise their ability to adapt to environmental changes.

Serious habitat degradation is evident in every region, state, territory, and community along the nation's coastline. Since the early settlers arrived in the United States, the nation has lost more than half of its wetlands—over 110 million acres.[2] California has lost 91 percent of its wetlands since the 1780s.[3]

Many mangrove forests, seagrass beds, and coral reefs have also fared poorly. Shallow-water reefs near urbanized coasts in the United States have been degraded by environmental and human disturbances such as hurricanes, fishing activities, coastal development, runoff, and sedimentation.[4] More than 50 percent of the historical seagrass cover has been lost in Tampa Bay, 76 percent in the Mississippi Sound, and 90 percent in Galveston Bay. Extensive seagrass losses have also occurred in the Chesapeake Bay, Puget Sound, San Francisco Bay, and Florida's coastal waters.[5] Climate change, rising global temperatures, and sea level rise will place additional stresses on coastal habitats.

Conserving Coastal Habitat

Conserving valuable ocean and coastal areas not only protects significant habitat and other natural resources, it also precludes the need to undertake costly restoration efforts after an area has been degraded or lost. Current conservation needs, however, are not being met—a situation that will continue to worsen with increasing pressures on ocean and coastal environments and rising demands for coastal land.

Habitat Conservation Programs

Millions of coastal acres have been designated for conservation by various levels of government, and the tools for implementing conservation programs are found in a multitude of statutes. A number of federal programs aim to preserve the natural attributes of specific areas while providing varying levels of access to the public for educational, recreational, and commercial purposes. These include the U.S. Department of the Interior's (DOI's) National Parks and Seashores, National Wildlife Refuges, National Monuments, and National Wilderness Areas; the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Sanctuaries and National Estuarine Research Reserves; and the U.S. Environmental Protection Agency's (EPA's) National Estuary Program.

DOI's U.S. Fish and Wildlife Service (USFWS) administers several programs that provide grants for the acquisition, restoration, and enhancement of coastal lands, including the National Coastal Wetlands Conservation Grants Program and a number of regional programs, such as the Pacific Islands Coastal Program. NOAA administers several programs that aim to conserve valuable coastal lands, restore degraded habitat, and advance the science of restoration technology. The U.S. Department of Agriculture's (USDA's) Wetlands Reserve Program facilitates the purchase of conservation easements from landowners to restore, enhance, or create wetlands, including coastal wetlands. The U.S. Army Corps of Engineers (USACE) conducts a variety of environmental stewardship and restoration programs. And both USACE and EPA are involved in conserving wetland habitats through the wetland permitting program under the Clean Water Act. (All of these programs and authorities are summarized in Appendix D.)

Coastal habitat conservation programs also exist at the state, territorial, tribal, and local levels. For example, marine protected areas (discussed in greater detail in Chapter 6) can be designated by different levels of government for a variety of reasons, including habitat conservation.

Nonregulatory conservation techniques—including fee simple land acquisition, the purchase or donation of easements, tax incentives and disincentives, and tradable development rights—play a special role in enabling willing landowners to limit future development on their land for conservation purposes. Land acquisition and easements are often implemented through partnerships among governments, nongovernmental organizations such as land trusts, and the private sector. These groups work together to leverage limited resources from project partners to fund projects and ensure that areas acquired for conversation purposes are properly managed. As coastal populations grow and demands on coastal lands intensify, the resources needed to make such conservation partnerships work will continue to increase.

Funding for Habitat Conservation

The Land and Water Conservation Fund is a major source of federal funding for conservation projects, authorized to provide up to $900 million a year in support of these projects. However, since the fund's inception in 1965, Congress has appropriated less than half of the amount authorized.[6] An even larger source of federal funding is administered by USDA's Natural Resources Conservation Service, whose conservation programs will handle a projected total of $38.6 billion over the next ten years.[7] Though neither of these funding sources is specifically targeted for the conservation of coastal and ocean resources, the funds can be used in those areas. Moreover, conservation of habitat in upland watersheds that enhances water quality indirectly benefits coastal areas.

Nevertheless, support for the direct conservation of coastal habitats represents a small fraction of federal spending. In 2002, Congress appropriated money for the Coastal and Estuarine Land Conservation Program to provide a dedicated funding source to support coastal conservation partnerships at state and local levels, but this program has not been made permanent.

Conservation is important to maintain critical habitats and the benefits they provide. It is also cost-effective, avoiding the much larger expense and scientific uncertainties associated with attempting to restore habitats that have been degraded or lost.

Recommendation 11–1. Congress should amend the Coastal Zone Management Act to authorize and provide sufficient funding for a dedicated coastal and estuarine land conservation program.

In order to achieve this:

- *each state coastal management program should identify priority coastal habitats and develop a plan for establishing partnerships among willing landowners for conservation purposes, with participation from local government, nongovernmental, and private-sector partners.*

Restoring Coastal Habitat

Once critical habitat has been lost, or the functioning of those areas diminished, restoration is often needed. Habitat restoration efforts are proliferating in response to heightened public awareness of and concern for the health of the nation's oceans and coasts. Several large-scale efforts are underway to restore the nation's unique ecological treasures, including coastal Louisiana, the Florida Everglades, the Chesapeake Bay, the San Francisco Bay-Delta, and the Great Lakes. The goals of these initiatives are extremely ambitious—reestablishing thousands of square miles of water flow and habitat to sustain healthy levels of fish and wildlife populations while maintaining water supply for human uses and allowing future development.

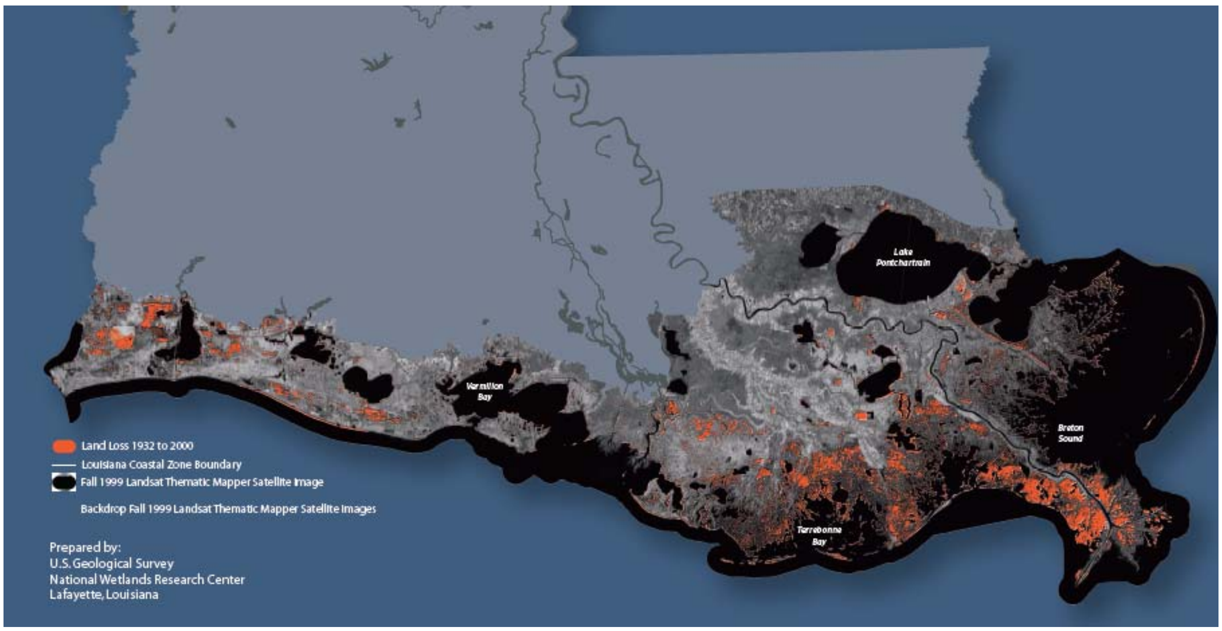
Large-scale restoration efforts are challenging in a number of ways. First, the success of these efforts requires an understanding about how to recreate natural systems and restore historical ecosystem functions, a field still in its infancy. Second, these efforts cross political boundaries and affect a broad range of human activities, requiring support and intense coordination among a wide range of governmental and nongovernmental stakeholders. While some restoration projects have been successful, continued progress will depend on sustained funding, government leadership and coordination, scientific research, and stakeholder support.

Improved regional coordination and the creation of regional ocean councils, as discussed in Chapters 5 and 6, would enhance the success of regional restoration initiatives. These mechanisms, in concert with the new regional ocean information programs, will place restoration initiatives in a necessary regional context and will meet the information needs so vital to the progress of these initiatives. Restoring historical ecosystem functions is one step—albeit a significant one—in sustaining the health of the nation's ocean and coastal resources. Over time, the regional ocean councils will also improve the management of all activities that affect coastal habitats and the well-being of coastal communities.

Examples of Coastal Habitat Loss and Restoration Efforts

Coastal Louisiana

Figure 11.1. Dramatic Coastal Land Loss in Louisiana



From 1932 to 2000, coastal Louisiana lost 1,900 square miles of land—an area roughly equivalent to the size of Delaware. An additional 700 square miles is expected to be lost over the next fifty years if no new restoration takes place, putting more than 2 million coastal residents at risk from floods and storms.
Source: U.S. Geological Survey. "Without Restoration, Coastal Land Loss to Continue." News release. <http://www.nwrc.usgs.gov/releases/pr03_004.htm> (Accessed January, 2004). Map courtesy of U.S. Geological Survey, Lafayette, LA.

Nowhere is the problem of habitat loss more compelling than in coastal Louisiana, which experiences about 80 percent of the total annual coastal land loss in the continental United States.[8] From 1956 to 2000, an average of 34 square miles of Louisiana's wetlands disappeared into the sea every year (Figure 11.1). If this rate of loss continues, an estimated 700 additional square miles of coastal wetlands will be lost over the next fifty years, threatening billions of dollars worth of resources vital to the state's—and the nation's—economic well-being.[9]

The devastating losses are the result of a number of converging factors, including both human activities and natural processes. Chief among them are the dams, levees, and channels developed along the Mississippi River and its tributaries, as well as a network of canals that provide access to oil and gas well sites. These projects, which have supported nationally important infrastructure, navigation routes, and energy supplies, have also resulted in a 67 percent decrease in the supply of sediments to the coastal area and have disrupted the natural flow of water that kept the wetlands healthy.[10] Sea level rise, coastal storms, destruction of marsh plants by muskrat and nutria, and the subsidence of the region over geologic time intensify the problem and put the state's more than two million coastal residents at increasing risk.

Restoration efforts have intensified since the passage of the Coastal Wetlands Planning, Protection, and

Restoration Act in 1990 (also known as the Breaux Act), which focused national attention and significant federal funding on hundreds of conservation and restoration projects. In 1998, a more comprehensive ecosystem-based plan to restore the natural processes of the region's coastal wetlands was jointly developed by the state of Louisiana and the federal government.[11] Strategies being developed in the Louisiana Comprehensive Coastwide Ecosystem Restoration Study, currently under review by the National Research Council, will determine the feasibility of sustaining Louisiana's coastal ecosystem.

The Florida Everglades

Another extensive effort to restore a regional ecosystem dramatically altered by human activities is taking place in the Florida Everglades, an unparalleled network of mangroves, coastal marshes, seagrass beds, lakes, rivers, estuaries, and bays that once stretched from Orlando to Florida Bay. A long history of water diversions, flood control projects and agricultural and urban development in South Florida has reduced the size of the Everglades by half, threatening or endangering numerous plant and animal species in the process.[12] As a result of altered water flows and development, the region has experienced numerous environmental problems such as nutrient enrichment, pesticide contamination, mercury buildup in plants and animals, widespread invasion by exotic species, increased algal blooms, seagrass die off, and declines in fishing resources.[13]

In 1992, Congress authorized a comprehensive review of the potential to restore the Everglades ecosystem. This review resulted in the development of the Comprehensive Everglades Restoration Plan, the largest restoration effort ever pursued based on the size of the ecosystem and the nearly 200 individual projects being developed to implement the plan.[14] Many of these projects involve massive and expensive engineering and construction feats designed to restore natural hydrological functions and water quality throughout the entire region. For example, the plan calls for the removal of 240 miles of levees and canals and the construction of a network of reservoirs, underground storage wells, and pumping stations to recreate historic water flow quantities, quality, timing, and distribution, while meeting the freshwater and flood protection needs of Florida's growing population. The National Research Council, which is performing an independent scientific peer review of the restoration effort, referred to it as demanding "the most advanced, interdisciplinary, and scientifically sound capabilities that the nation has to offer."[15]

Despite its immense size and scope, the Comprehensive Everglades Restoration Plan is only one component of an initiative to restore the southern half of the state and the nearshore waters of Florida. The larger effort is being headed by the South Florida Ecosystem Task Force, which is charged with developing a strategy for coordinating hundreds of projects carried out by several different federal, state, tribal and local entities, universities, and other stakeholder groups. The Task Force is made up of senior level officials from seven federal agencies, the Florida Department of Environmental Protection, the Miccosukee and Seminole tribes, the South Florida Water Management District, the Florida Governor's Office, and two local governments.

In addition to the large-scale, regional restoration efforts described above, there are numerous small-scale efforts that collectively make significant contributions—such as the restoration of particular wetlands, bays, riverbanks, and streams. These activities often demonstrate the power of public–private partnerships, bringing together community members, government agencies, and businesses to solve common problems. However, as long as each project continues to be planned and implemented in isolation, its overall impact will be constrained.

A Small-scale Habitat Restoration Effort: Friends of Heeia State Park

There are thousands of examples of local efforts in which concerned citizens, government entities, business, and other stakeholders have helped restore coastal habitats valuable to both native plant and animal species and to the culture of the local community. Friends of Heeia State Park, a nonprofit educational institution located on the Hawaiian Island of Oahu, coordinates several community restoration activities each year during which local volunteers help clean up beaches and streams, monitor water quality, and remove invasive species. Recently, the group received a grant from the Environmental Protection Agency to conduct a project replacing non-native coastal plants, which were preventing adequate filtering of waters from the watershed to the Heeia Bay, with native species. The project was part of a larger effort to restore portions of the entire Heeia watershed that had become degraded by nonpoint source pollution originating from various human activities. Thousands of volunteers participated in the project.[16]

These and other local restoration efforts are vital components of the overall goal of improving the health of coastal habitats nationwide. They also serve a valuable role in promoting coastal stewardship by instilling a sense of ownership and responsibility throughout the community. Improving communication and coordination among these efforts, and enhancing the research efforts needed to determine the most effective restoration strategies, will strengthen the ability of individual restoration projects to contribute to the overall improvement of ocean and coastal health.

Because coastal habitat restoration efforts are costly and complicated, they require the participation of a wide range of stakeholders to accomplish goals not achievable by any one party. Over the past ten years, the Coastal America partnership has proven to be a useful mechanism for bringing together disparate groups to improve the health of the coastal environment, one project at a time. Coastal America was officially formed in 1991 through a Memorandum of Understanding signed by several federal departments and agencies. A major impetus for the program was the need to overcome institutional barriers and inconsistent federal agency jurisdictions and authorities to develop and implement mutual restoration goals. Since its inception, Coastal America has facilitated over 600 collaborative projects enlisting the help of 12 federal departments, 250 state and local governments, and over 300 private businesses and organizations.[17] Project activities have included wetlands restoration, dam removal, species protection, and pollution mitigation.

The success of individual coastal habitat restoration efforts—whether large- or small-scale—can be enhanced through the development of comprehensive regional restoration strategies which will vary according to the unique circumstances in each region. An overarching national strategy that sets goals and priorities can also enhance the effectiveness of regional efforts and provide a basis for evaluating progress.

In 2000, the Estuary Restoration Act called for a national strategy to include the goal of restoring one million acres of estuarine habitat by 2010. The Act established an interagency council to develop the strategy, create a comprehensive approach to estuarine habitat restoration efforts, foster coordination of federal and nonfederal activities, and administer a program for setting priorities and providing appropriate technical and financial assistance. In 2002, the Estuary Habitat Restoration Council—chaired by USACE and made up of designees from NOAA, EPA, USFWS, and USDA—published its final strategy, which encourages an ecosystem-based approach, including strengthening public–private partnerships and applying innovative restoration technologies, monitoring capabilities, and performance measurement tools.[18]

It is too soon to speculate on the success of the Estuary Habitat Restoration Council or its strategy, although the establishment of a forum for federal agency coordination and communication at the national level is a significant and positive step. There remains, however, a need for a federal coordinating forum with responsibilities and membership that is broader than the Estuary Habitat Restoration Council—one that can coordinate the development and implementation not only of estuarine habitat restoration efforts, but activities that affect all types of coastal habitat and include conservation as well as restoration measures.

Improving Habitat Conservation and Restoration

Currently the many entities that administer conservation and restoration activities operate largely independently of one another, with no framework for assessing overall benefits in an ecosystem-based context. The multitude of disjointed programs prohibits a comprehensive assessment of the progress of conservation and restoration efforts and makes it difficult to ensure the most effective use of limited resources.

Recommendation 11–2. The National Ocean Council should develop national goals for ocean and coastal habitat conservation and restoration efforts and should ensure coordination among all related federal activities. The regional ocean councils and regional ocean information programs should determine habitat conservation and restoration needs and set regional goals and priorities that are consistent with the national goals.

Enhancing Information and Understanding

One of the most significant obstacles to conservation efforts is the lack of adequate knowledge about the structure and functioning of coastal habitats and the relative effectiveness of restoration techniques. Furthermore, many individual efforts do not benefit from the knowledge and positive experiences that do exist. Enhanced support for ecosystem restoration science and applied research on effective restoration techniques is needed, as is support for programs that educate practitioners on how to implement these techniques. A better understanding of the connections between human activities and their impacts on coastal habitats will lead to better management of coastal resources and a strengthened stewardship ethic among all stakeholders and citizens.

Coordinated and comprehensive inventories and assessments are essential for identifying critical habitats, evaluating the causes of habitat loss and degradation, and setting priorities for conservation and restoration efforts, thus enabling decision makers to focus limited resources on the most pressing needs. The regional ecosystem assessments to be developed through the regional ocean information programs (Chapter 5) will provide timely and comprehensive information on the status of coastal habitats.

In addition to improved understanding and broad national assessments and inventories, the nation needs better ongoing monitoring. Currently, most federal funding available for conservation and restoration efforts can only be used for direct implementation, not for the equally important tasks of monitoring the success of these efforts and further advancing restoration science.

Finally, conservation and restoration efforts must build on past successes to achieve progress. Currently, there is no accessible nationwide system for sharing information, including research results, planning processes, conservation and restoration techniques, and funding opportunities. A broadened and redefined Estuary Habitat Restoration Council could serve as a mechanism for this type of information sharing. Information pertinent to coastal habitat conservation and restoration efforts can also be shared through the regional ocean councils and regional information collection programs.

Recommendation 11–3. Congress should amend relevant legislation to allow federal agencies greater discretion in using a portion of habitat conservation and restoration funds for related assessments, monitoring, research, and education.

Protecting the Nation's Wetlands: A Special Case

Coastal wetlands, including marshes, swamps, and bogs, are an important and integral component of coastal habitats. USACE regulations define wetlands as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support vegetation that typically lives in saturated soils. Coastal watersheds currently include about 30 percent of all wetlands in the lower forty-eight states, or approximately 27 million acres.[19] Like other coastal habitats, wetlands provide a variety of valuable ecosystem services, such as improving water quality, providing natural flood control, recharging groundwater, stabilizing shorelines, contributing to recreational value, and serving as nursery areas for thousands of species of plants, fish and other animals.

The functions and values wetlands provide have not always been recognized. Prior to the 1970s, federal policies for agriculture, development, and insect control encouraged the draining and filling of wetlands—referred to disparagingly at the time as swamps. A 2001 National Research Council report found that, as a result, by the 1980s the wetland area in the contiguous United States had decreased to approximately 53 percent of what it had been one hundred years earlier.[20]

By the late 1980s, the protection of wetlands had become a national priority and federal policies began to shift. In 1989, President George H.W. Bush acknowledged the importance of wetlands by establishing the goal of "no net loss of wetlands," a goal that has been supported by subsequent administrations. As a result of these shifts in attitude and policy, the rate of wetlands loss has decreased substantially, although there is uncertainty as to the extent of the decrease, especially with regard to the functional value of wetlands.[21] Nevertheless, wetlands continue to be lost due to subsidence, erosion, storms, and human activities, including the conversion of such areas for other uses.

There is no single, comprehensive federal wetlands protection law. Instead, multiple federal statutes and programs provide protections in different forms, including the various conservation and restoration programs described earlier in this chapter. State and local wetland programs add to the complexity of wetlands protection efforts.

The Clean Water Act Section 404 program is the primary federal regulatory program providing protection for the nation's wetlands. The goal of the program is to avoid deliberate discharges of materials into wetlands, or minimize discharges where they cannot be avoided. The program requires a permit for any discharge of materials, such as soil or sand, into U.S. waters. If a permit is issued for a project that will result in the loss of wetlands, compensatory mitigation is often required; that is, wetlands must be restored, enhanced, preserved, or created elsewhere to replace the permitted loss of wetland acres and functions.

Although it has had some success in slowing the rate of wetlands loss, the Section 404 program is not a true national wetlands management and protection program. The program is limited to fill permitting and does not address the many other activities that affect wetlands. In addition, several major categories of activities are not required to obtain permits, including ongoing farming, ranching, silviculture, and USACE Water Resources Development Act projects. The program has also generally failed to give sufficient consideration to the cumulative impacts associated with issuing multiple individual permits in the same geographic or watershed area. (A more detailed discussion on improving the ability of USACE to address the regional, cumulative impacts of its activities is provided in Chapter 12.)

As the nation recognizes the interconnectedness of upland and downstream areas, considers entire watershed systems, and moves toward an ecosystem approach, comprehensive wetlands protection should be considered as an integral part of ocean and coastal management.

Recommendation 11–4. The National Ocean Council should coordinate development of a comprehensive wetlands protection program that is linked to coastal habitat and watershed management efforts and should make specific recommendations for the integration of the Clean Water Act Section 404 wetlands permitting process into that broader management approach.

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CHAPTER 12:

MANAGING SEDIMENT AND SHORELINES

The natural flow of sediment over land and through waterways is important for sustaining coastal habitats and maintaining attractive beaches. However, excess, insufficient, or contaminated sediment can erase beaches, destroy habitats, poison the food chain, and endanger lives. Because navigational dredging, infrastructure projects, farming, urban development, and many other necessary and beneficial human activities can interfere with natural sediment processes, their impacts should be understood and managed. A national strategy for managing sediment on a multi-project, regional basis, that accounts for ecosystem and economic needs and involves all relevant parties, is needed to promote greater beneficial uses of sediment with less harm to natural resources. Improved methodologies for evaluating beneficial uses, along with additional research, monitoring, assessment, and technology development, will also be necessary to achieve improved sediment management.

UNDERSTANDING THE DUAL NATURE OF SEDIMENT

Sediment in Great Lakes, coastal, and ocean waters is composed of inorganic and organic particles created through erosion, decomposition of plants and animals, and human activities. Sediment may be carried by wind or water from upland areas down to coastal areas, or may originate in the marine environment. Once sediment arrives at the ocean, it is transported by wind, waves, and currents in dynamic processes that constantly build up and wear away cliffs, beaches, sandbars, inlets, and other natural features.

From a human perspective, sediment has a dual nature—desirable in some locations and unwanted in others (Figure 12.1). Sediment can be used to create or restore beaches and to renew wetlands and other coastal habitats. Such activities are referred to as beneficial uses. Undesirable sediment can cloud water and degrade wildlife habitat, form barriers to navigation, and contaminate the food chain for marine plants, animals and humans.

Whether sediment is desirable or not, its location and movement can have large economic and ecological consequences. For example, excess sediment in shipping channels may cost ports millions of dollars in delayed or limited ship access, while in other locations insufficient sediment deposits could result in the loss of valuable coastal wetlands.

Figure 12.1. Sediment: Friend or Foe

Too much sediment can lead to …	Too little sediment can lead to …	Valuable uses of sediment include …
obstructed channels overflowing rivers smothered reefs high turbidity that blocks sunlight	disappearing beaches eroded riverbanks wetlands losses altered river profiles	construction material sand to replenish beaches wetland nourishment replacement of agricultural soil

Sediment levels that are too high or too low can be detrimental to both natural environments and man-made structures, including extreme cases where structures are lost due to beach and cliff erosion. But sediments such as sand and gravel can also be viewed as a valuable resource.

Source: Martin, L. R. *Regional Sediment Management: Background and Overview of Initial Implementation*. Institute for Water Resources Report 02-PS-2. Alexandria, VA: U.S. Army Corps of Engineers, July 2002.

The dual nature of sediment as both a threat and a resource to humans and the environment makes its management particularly challenging. To complicate matters further, the natural processes that create, move, and deposit sediment operate on regional scales, while management tends to focus on discrete locations—a single beach, wetland, or port. In addition, the policies that affect sediment location, transport, and quality fall under the jurisdiction of diverse programs within multiple agencies at all levels of government. This complex governance approach makes it difficult to manage sediment at the appropriate scale and in consonance, rather than in conflict, with natural processes.

Federal Roles in Sediment Management

The federal government's role in managing sediment in the marine environment covers five areas: navigation-related dredging; beneficial use of sediment; construction of infrastructure to reduce flooding and erosion hazards; management of contaminated sediment; and basic and applied research into sediment processes. As with many ocean and coastal issues, numerous federal agencies are involved.

The U.S. Army Corps of Engineers (USACE) plays a large part in nearly all of these areas and is the lead agency for all but contaminated sediment. The U.S. Environmental Protection Agency (EPA) has environmental oversight of dredging projects and is tasked as the lead agency for disposal of contaminated dredged materials and cleanup of contaminated sites. The National Oceanic and Atmospheric Administration (NOAA) administers the Coastal Zone Management Program, which requires participating coastal states to have enforceable policies to protect ocean and coastal resources, including policies that affect sediment management. NOAA's National Marine Fisheries Service and the U.S. Department of the Interior's (DOI's) U.S. Fish and Wildlife Service have responsibilities for living marine resources and habitat that also give them a role in evaluating the impacts of proposed sediment projects. DOI's Minerals Management Service identifies and authorizes access to sand deposits in federal waters suitable for beach nourishment and wetlands protection projects. The U.S. Geological Survey advances research on the sources, transport, impacts, disposal, beneficial use, and other aspects of sediment. USACE, NOAA, and EPA also conduct related research efforts, and the National Science Foundation and Office of Naval Research fund many relevant academic studies.

Other federal programs have less direct, but no less important impacts on sediment. The U.S. Department of Agriculture's Natural Resources Conservation Service plays a central role in efforts to reduce agricultural soil erosion, much of which finds its way to the ocean. USACE and DOI's Bureau of Reclamation operate flood control, water storage, and hydroelectric projects which retain, and occasionally release, large amounts of sediment. Sediment also is addressed extensively through the nation's regulation of point and nonpoint sources of pollution, with EPA and NOAA as the principal federal agencies involved.

Some activities that affect sediment, such as dredging and shoreline erosion control projects, fall within the authorities of specific laws, often implemented in isolation from each other. Other activities are addressed under broader, less specific authorities. No mechanism exists to ensure that each individual sediment-related project is considered in the context of other overlapping activities. Even well designed projects can sometimes create more problems than they solve, or encounter frustrating delays, because of poor communication among stakeholders and confusion about the many programs that remove, relocate, prevent, or accelerate the transport of sediment.

Altering Sediments through Human Intervention

Changing Sediment Quantities

Many human interventions in sediment processes are unintentional, occurring as a by-product of routine economic activities that overload or deprive natural systems of sediment. Activities such as forestry, agriculture, and urban development yield great benefits to the nation, but also accelerate natural erosion. Excess sediment suspended in the water column or accumulating at the bottom of water bodies can create problems for other industries, such as shipping, fishing, and tourism, and can harm aquatic life.

Conversely, flood control, water supply, and hydroelectric projects prevent the natural movement of sediment, contributing to downstream erosion and subsidence problems. As older components of this infrastructure become too costly to maintain, or are rendered obsolete for structural or economic reasons, disposing of the enormous quantities of trapped sediment will pose a new set of problems. Development in coastal communities can also disrupt natural sediment movement, causing erosion in some places and accretion in others. Such projects may have unintended effects on neighboring jurisdictions, both upstream and downstream, that had no role in the planning process.

Changing Sediment Quality

Over the last fifty years, lakes, rivers, and harbors have accumulated bottom sediments contaminated with heavy metals (such as lead, copper, and arsenic) from mining and industrial activities, as well as long-lived toxic chemicals (such as DDT, MTBE, PCBs, and dioxin). Continued discharges from municipal waste and industrial plants, and polluted runoff from agricultural and urban sources, perpetuate the problem, while newly identified contaminants such as flame retardants are now being detected in ocean and coastal sediments. Toxic chemicals from sediment can accumulate in marine plants and animals, causing reproductive failure, impaired growth, disease, and death. They may also pose health risks to humans who consume or come in contact with tainted marine products.

Of the 12 billion cubic yards of sediment that comprise the top two inches underlying U.S. waters, an estimated 10 percent is thought to be contaminated at levels that pose possible risks to marine life, wildlife, and humans.[1] Of the 300 million cubic yards of sediment the USACE dredges annually to facilitate navigation, an estimated 5 to 10 percent is contaminated.[2] Once a portion of sediment becomes contaminated, it becomes a source of further contamination downstream.

Currently, six laws and seven federal agencies are involved in dredging or remediation of contaminated sediment, depending on whether the material is to be removed, deposited, or treated. Different sets of laws apply when navigational dredging or environmental cleanup are the primary focus of activity. A 1997 National Research Council report concluded that this patchwork of laws generally fails to manage contaminated sediment according to the risk it poses to the environment, does not adequately weigh the costs and benefits of different solutions, and imposes lengthy and unnecessary delays in addressing problems.[3]

The Comprehensive Environmental Response, Compensation and Liability Act, more commonly referred to as Superfund, provides for the cleanup of uncontrolled or abandoned hazardous waste sites. At over one hundred locations, bottom sediments in rivers and harbors are so contaminated they are designated as Superfund sites. The EPA estimates that cleanup of the thirty most highly contaminated sites in rivers, lakes, and coastal areas may cost hundreds of millions of dollars.[4]

The Legacy of Sediment Contamination

Long-term remedial response action is required at areas on EPA's Superfund list, one of which is Fox River and Green Bay, Wisconsin. From 1954 to 1971, PCBs were released during the manufacture of carbonless copy paper by seven companies along the banks of the river. The chemical releases left 11 million cubic yards of contaminated sediment in Fox River and Green Bay. The EPA estimates that up to 70% of the PCBs entering Lake Michigan via its tributaries come from the Fox River. This contamination has affected water quality, recreation, and the health of people, fish, and birds. Elevated PCB concentrations in some Lake Michigan fish have prompted health advisories. Native Americans in the area have been particularly affected because of the importance of subsistence fishing to their community. [5,6]

The presence of contaminated sediment greatly complicates the management of dredged materials. For example, contaminated sediment would be inappropriate for use in wetland restoration or erosion control projects. Costs are also much higher for the safe and secure disposal of these materials. The very process of dredging contaminated sediment increases ecological and human health risks because some of the sediment inevitably becomes resuspended and carried to new locations during removal.

Developing Regional Strategies for Sediment Management

Sediments flow continuously downstream to the coast, on and offshore, and back and forth along the coast. A project-by-project approach to sediment management can result in expensive actions that may undermine the interests of other stakeholders. For example, flood and erosion control structures, while temporarily protecting targeted locations, interrupt the natural transport of sediment along the coast, preventing the accumulations that create beaches and maintain wetlands, exacerbating coastal erosion, and potentially threatening life, property, and coastal economies in other locations. Similarly, upstream sediment diversions or contamination can have major impacts in estuaries and coastal areas.

Coastal stakeholders have increasingly recognized the need to develop more proactive and preventive strategies. However, their absence from broad watershed planning efforts—where decisions about land use and water management could reduce excess and contaminated sediments at their source—makes such change difficult to realize. (A more detailed discussion of watershed planning efforts appears in Chapter 14.) The nation needs both a better understanding of the interactions between human activities and sediment flows, and a better mechanism for involving all potentially affected parties.

Moving toward an ecosystem-based management approach is a critical step. The new National Ocean Policy Framework outlined in Part II creates a structure for regional coordination and cooperation among the many parties affected by sediment. Participation by federal, state, and local entities in watershed management efforts, along with key stakeholders such as coastal planners and port managers, is one way to diminish upland sources of excess and contaminated sediment that harm the marine environment. Ecosystem considerations should be included in the process for permitting any activity that alters sediment flows.

Recommendation 12-1. The National Ocean Council should develop a national strategy for managing sediment on a regional basis, taking into account both economic and ecosystem needs. The strategy should: consider adverse impacts on marine environments due to agriculture, dredging, pollutant discharges, and other activities that affect sediment flows or quality; ensure involvement of port managers, coastal planners, and other stakeholders in watershed planning; and require that ecosystem-based management principles serve as the foundation for permitting processes for activities that affect sediment.

Regional sediment management will require coordination among diverse interests, political jurisdictions, and levels of government to achieve environmental, social, and economic goals. For example, construction and restoration projects in coastal areas often face long permitting and planning delays, which can substantially add to project costs and be ecologically detrimental. A regional sediment planning process that identifies pre-approved beneficial use sites through a collaborative stakeholder process could help expedite projects, resulting in quicker realization of economic benefits to the region.

A regional approach could also help prioritize projects. In considering beach nourishment proposals for two nearby sites, priority might be given to one of the sites if natural sediment transport processes would result in secondary nourishment of the down-coast site, doubling the impact of the investment. Regional sediment management could also inform coastal land use planning and permitting decisions, moving new development or post-disaster rebuilding away from erosion hot spots, as discussed in Chapter 10.

One of the difficulties in undertaking a regional approach to managing sediment is that the definition of a region may differ substantially among parties engaged in land use planning, port management, coastal development, wetlands protection, or fisheries. To understand the sources and transport of sediment, a region might extend tens to hundreds of miles up and down rivers and the coastline. Alternately, for management of dredged material at a port, the region might be linked to the size of that port. Coastal erosion and living marine resources may define other scales. These definitions should be reconciled to achieve effective sediment management in an appropriate regional context.

Moving Toward Regional Sediment Management at USACE

USACE's traditional protocols for dredging and other sediment management projects consider the impacts of those projects individually and on short-term and local scales—typically from one to thirty years, across areas of less than ten miles—despite widespread recognition that coastal processes operate at regional scales with time frames of up to 250 years and geographic extents of dozens of miles from a project's location.[7] In many cases, this disregard for the scale over which natural processes operate has resulted in projects having unintended adverse impacts on nearby coastal resources, placing too much sediment in the wrong place or too little where it is needed.

More recently, USACE, with support from Congress, has begun pursuing alternatives to its project-by-project approach. For example, USACE created the Regional Sediment Management Program based on general direction from Congress to develop long-term strategies for disposing of dredged materials and cooperate with states to develop comprehensive plans for coastal resource conservation. Under the program, USACE collaborates with states, communities, and other diverse stakeholders to develop plans to manage sediment across a region that encompasses multiple USACE dredging projects.

To date, the Regional Sediment Management Program has undertaken six demonstration projects around the country. Early results have yielded technology improvements, information sharing, and the building of a base of experience in more comprehensive management of construction activities affecting sediment. Nevertheless, scientific, technological, and institutional hurdles remain to implementing truly regional sediment management.[8]

Weighing the Costs and Benefits of Dredging

Navigational Dredging

Widespread adoption of regional sediment management practices will help address many problems. However, until such practices are common—and even once such frameworks are in place—certain sediment activities merit special attention. Dredging for navigational purposes is perhaps the most direct and prominent way humans affect sediments in marine waters. The federal government is most clearly in charge of dredging activities for this purpose.

Navigational dredging in ports and waterways seeks to remove accumulated sediment that blocks or endangers vessels and prevents access by ships that continue to increase in size and draft, requiring wider and deeper channels. An estimated 400 million cubic yards of sediment (300 by USACE and another 100 by private, permitted contractors) are dredged annually to maintain and improve navigation.[9] As the volume and value of goods transported by water continues to grow, the importance of maintaining efficient, modern ports increases. (Chapter 13 includes a broader discussion of port planning in the context of maritime commerce and transportation.) All dredging, whether related to navigation or not, can have negative impacts. These impacts may include habitat disturbance and the dispersion of sediment—frequently contaminated—to new locations, with unintended impacts on the ecosystem.

One frequent complaint associated with dredging projects is the time involved from conception to completion. Currently, the process of planning, permitting, and completing a navigation channel improvement project (widening or deepening) can take more than twenty years. Reasons for delay include inconsistent funding allocations and congressional approvals, the complexity of the project review process, and scientific uncertainties. Such lengthy time frames can be ecologically and economically detrimental to a region. Delayed access to a port may reduce ship traffic and trade, and environmental impact statements may become outdated. At the same time, certain projects may be legitimately questioned by those who believe there are less costly or environmentally damaging alternatives.

EPA and USACE are currently investigating mechanisms for improving the efficiency of the planning and permitting process for management of dredged material. These efforts should be encouraged. A streamlined process should be designed to evaluate the necessity of a proposed dredging project, look for opportunities to improve sediment management, and set priorities among projects.

Beneficial Uses of Dredged Material

Dredged materials have long been used to create new land for commercial, residential, and infrastructure developments, as well as to bolster beaches and barrier islands to protect against storm and erosion hazards and enhance tourism and recreation. Since the 1970s, these beneficial uses of dredged materials have also included environmental enhancement, such as restoration of wetlands, creation of wildlife habitat, and improvement of fish habitat. Surprisingly, navigation-related dredged materials do not find their way into beneficial use projects as often as perhaps they should. This is due in part to sediment contamination, but also to USACE policies that favor disposal in open waters or in upland dump sites. These policies may be unnecessarily foregoing opportunities to support economic growth or environmental protection and may have serious unintentional consequences for aquatic ecosystems.

Beach Nourishment: A Special Use of Sediment

Dredging of sediments does take place outside the navigation context, most notably for use in beach nourishment projects. Beach nourishment can be important in protecting natural systems such as reefs and downstream coastal environments. However, beach nourishment for recreation, tourism, and protection of beachfront property has been the primary area of contention. As fervently as some champion beach nourishment as a source of national economic benefit essential to protecting life, property, and beach-dependent economies, others decry it as a costly taxpayer-subsidized activity that creates incentives for inappropriate development in coastal areas subject to storm, flooding, and erosion hazards. USACE can help fund beach nourishment projects when a federal navigation or other infrastructure project has eroded the beach, or when a local community makes a specific request that is authorized and funded by Congress.

As the National Research Council noted in a 1997 report, the process for determining when, where, and how to use dredged sediments for beach nourishment suffers from a number of deficiencies, including a lack of performance criteria, inadequate technical and economic methodologies, outdated design standards, insufficient stakeholder involvement, an inadequate understanding of the physical and biological mechanisms of beach and littoral systems, and a failure to plan for the long term or in a regional context.[10] Because the high costs of undertaking and maintaining these projects are borne in large measure by the public, investments should target projects that will render the greatest benefit and where other alternatives, such as moving development away from eroding areas, are not possible. Achieving this goal will require a better understanding of sediment processes and a method for considering beach nourishment proposals in a regional context.

Techniques of Cost-Benefit Analysis

Under current USACE policies, navigation-related dredged material is primarily viewed as a waste stream and diversion for beneficial use is considered extraneous to the navigation mission. For the federal government to cover the costs of a navigational dredging project, USACE regulations require that the dredged material be disposed of in the "least costly, environmentally acceptable manner consistent with engineering requirements established for the project." During its project evaluation process, USACE determines the least-costly disposal method, designated as the Federal Standard, and decides on the appropriate cost sharing structure with nonfederal partners. If the Federal Standard option is not used, the nonfederal partners must assume a larger portion, sometimes over 50 percent, of the project costs.

Because USACE cost-benefit methodologies tend to undervalue the benefits of projects that use dredged materials, while failing to account for the full costs, including environmental costs, of traditional disposal methods, the least-cost option generally favors open-water disposal of dredged materials. A more accurate system for selecting and ranking projects would be based on a comparative net economic and environmental return for the United States rather than a narrow cost-benefit analysis for a specific project. Recognizing the advantages of beneficial-use projects may also justify spreading the costs among a wider array of stakeholders.

Recommendation 12-2. The U.S. Army Corps of Engineers should ensure that its selection of the least-cost disposal option for dredging projects reflects a more accurate accounting of the full range of economic and environmental costs and benefits for options that reuse dredged materials, as well as for other disposal methods.

National and Regional Dredging Teams

Recognizing the benefits of improved sediment management, several ports have developed long-term plans for managing dredged materials. These include the ports of Baltimore, Boston, Houston, Long Beach, Los

Angeles, New York and New Jersey, Oakland, Seattle, and Tacoma. These long-term plans were intended to avoid delays caused by new environmental testing procedures, the determination that some dredged materials were not suitable for ocean disposal, and the lack of disposal alternatives, all of which had added years to the expected completion of some port expansion and navigational dredging projects.

Long-term planning efforts for managing dredged materials can bring together federal agencies, port authorities, state and local governments, natural resource agencies, public interest groups, the maritime industry, and private citizens to forge agreements that, among other things, increase the likelihood of beneficial use of dredged materials. These types of initiatives were encouraged by a 1994 Interagency Working Group report to the Secretary of Transportation, *The Dredging Process in the United States: An Action Plan for Improvement.*

The Action Plan concluded that early acknowledgment of environmental concerns and effective public outreach could substantially reduce potential conflicts and delays. Specific recommendations included: creation of a timely, efficient and predictable regulatory process; support for port or regional scale planning by partnerships that involve the federal government, port authorities, state and local governments, natural resource agencies, public interest groups, the maritime industry, and private citizens prior to seeking project approval; involvement of dredged material managers in watershed planning to emphasize the importance of reducing sediment loadings and contamination at their source; and encouragement for the environmentally sound, beneficial use of dredged materials, such as wetlands creation and beach replenishment. The Action Plan also emphasized the need to continually integrate the best available science. Three years after the Action Plan's publication, a 1997 National Research Council report echoed the plan's findings and recommendations.[11]

Implementation of the task force recommendations has been uneven. The National Dredging Team was established in 1995, but not all of the recommended regional teams were established. EPA's coastal and Great Lakes programs are currently forming regional teams, co-chaired by EPA and USACE, with participation by NOAA, the U.S. Fish and Wildlife Service, and local agencies that have regulatory roles in management of dredged material.

Recommendation 12-3. The National Dredging Team and regional dredging teams should begin to implement more ecosystem-based approaches. The National Dredging Team should implement the recommendations of the 1994 report to the Secretary of Transportation, *The Dredging Process in the United States: An Action Plan for Improvement*, with a priority of developing and implementing a streamlined permitting process. Regional dredging teams, working with regional ocean councils, should establish sediment management programs that include watersheds, coastal areas, and the nation's shoreline.

Improving Understanding, Assessment, and Treatment

An enormous stumbling block to improved sediment management is a poor understanding of sediment processes in the marine environment and a paucity of effective management techniques. This is particularly true for contaminated sediment.

Numerous ongoing research programs exist to improve the nation's understanding of sediments and sediment management techniques, but they are generally fragmented, uncoordinated, and often inadequately funded. Despite some scientific advances, these programs have not produced the needed engineering models, innovative management techniques and technologies, or comprehensive information about the source, movement, location, volume, quality, and appropriate use or disposal of sediment on a regional and national basis.

The National Shoreline Management Study, a USACE initiative launched in 2002, holds promise for yielding information to better coordinate and synthesize federal sediment activities. The study is examining why, where, and to what extent U.S. shorelines erode or accrete and will investigate other aspects of sediment management such as economic and environmental issues and the roles of stakeholders in shoreline management. The study's results could help establish national priorities for shoreline management, but only if there is a mechanism for translating those results into action. In addition to maintaining the National Shoreline Management Study, which looks primarily at physical shoreline processes, USACE should significantly expand support for research and monitoring of ecological and biological functions and processes.

USACE's role in major construction projects that significantly alter watersheds brings with it an obligation to understand the potential impacts of these activities prior to their implementation. Current project-by-project planning and funding, along with severely limited discretionary funds for broader ecosystem research, have made this extremely difficult. Existing funding formulas also severely limit post-project monitoring, precluding long-term analyses of project outcomes and adoption of adaptive management.

Recommendation 12-4. The U.S. Army Corps of Engineers (USACE), National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, and U.S. Geological Survey should develop a strategy for improved assessment, monitoring, research, and technology development to enhance sediment management. Congress should modify its current authorization and funding processes to encourage USACE to monitor outcomes from past projects and study the cumulative, regional impacts of its activities within coastal watersheds and ecosystems.

Because substantial reductions of contaminated sediment from upland sources remains a challenge, additional severely tainted marine sites are likely to be created. Yet the characterization, containment, removal, and treatment of contaminated sediment continue to be technically difficult and prohibitively expensive.

Recent EPA and National Research Council reports recognize the difficult ecological and economical problems associated with contaminated sediment management and stress the importance of adopting an adaptive management approach to the problem.[12,13] Scientifically sound methods for identifying contaminated sediment and developing innovative technologies to improve dredging and treatment of this material are critical steps toward improving the economic and ecological health of coastal areas. To be successful, these efforts will require new resources and effective regional planning.

Recommendation 12-5. The U.S. Environmental Protection Agency, working with other appropriate entities, should develop a coordinated strategy for assessment, monitoring, and research to better understand how contaminated sediment is created and transported, and to develop technologies for better prevention, safer dredging of such sediment, and more effective treatment after it is recovered.

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[9] Interagency Working Group on the Dredging Process. *The Dredging Process in the United States: An Action Plan for Improvement. A Report to the Secretary of Transportation.* Washington, DC: U.S. Environmental Protection Agency, 1994.
[10] National Research Council. *Contaminated Sediments in Ports and Waterways: Cleanup Strategies and Technologies.* Washington, DC: National Academy Press, 1997.
[11] Ibid.
[12] U.S. Environmental Protection Agency. "Draft Contaminated Sediment Remediation Guidance for Hazardous Waste Sites." *Federal Register* 67 (December 3, 2002): 71964.
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Chapter 13: Supporting Marine Commerce and Transportation

Marine commerce and transportation are vital to the nation's economy and security. The waterborne movement of cargo and passengers requires an efficient marine transportation system that is smoothly connected to the nation's inland highway and rail infrastructure to meet current and future demands. In addition, improving the nation's marine transportation system depends on improved interagency coordination including between marine transportation and other important ocean and coastal activities, enhanced emergency preparedness and security at the nation's ports, and improved strategic planning to ensure that increased levels of marine commerce are managed in the most effective, safe, secure, and environmentally responsible manner possible.

Connecting People, Places, and Products

Value of the Marine Transportation System

The U.S. marine transportation system is the nation's link to global commerce and an essential and growing component of the national economy. The movement of manufacturing jobs from the United States to overseas, the nation's dependence on raw materials from other countries, global competition to provide high-quality goods at competitive prices, and consumer demand have combined to increase the nation's dependence on the import of foreign materials and goods. At the same time, increasing affluence in foreign nations, coupled with worldwide population growth, has stimulated international demand for U.S. agricultural and manufactured products.

The world's oceans and inland waterways are the highways of choice for the global movement of this vast international trade. As the world's largest trading nation, the United States imports and exports more merchandise than any other country and has one of the most extensive marine transportation systems in the world (Table 13.1).[1] U.S. marine import-export trade accounts for nearly 7 percent of the nation's gross domestic product.[2] Domestically, coastal and inland marine trade amounts to roughly one billion tons of cargo, worth more than $220 billion a year.[3]

Table 13.1. The Leading Role of the United States in International Trade
In 2000, the United States led the world in the value of trade conducted. U.S. trade accounted for 19 percent of total world imports and 12 percent of total world exports of merchandise.

Rank in 2000	Exporters	Value (Billions of current U.S. Dollars)	Percent	Rank in 2000	Importers	Value (Billions of current U.S. Dollars)	Percent
1	United States	781	12.3	1	United States	1,258	18.9
2	Germany	552	8.7	2	Germany	503	7.5
3	Japan	479	7.5	3	Japan	380	5.7
4	France	298	4.7	4	United Kingdom	337	5.1
5	United Kingdom	284	4.5	5	France	305	4.6
6	Canada	277	4.3	6	Canada	245	3.7
7	China	249	3.9	7	Italy	236	3.5
8	Italy	238	3.7	8	China	225	3.4
9	Netherlands	213	3.3	9	Hong Kong	214	3.2
10	Hong Kong	202	3.2	10	Netherlands	198	3

Source: U.S. Department of Transportation, Bureau of Transportation. *International Trade Statistics, 2001*. <http://www/wto.org/english/res_e/statis_e/its2001_e/i05.xls> (Accessed June, 2002).

The U.S. marine transportation system is a complex public–private sector partnership with many participants. It is an aggregation of state, territorial, local, and privately-owned facilities wherein federal, state, territorial, and local governments participate in management, financing, and operation. The system is a highly complex and interconnected mix of waterways, ports and terminals, water-based and land-based intermodal connections, vessels, vehicles, equipment, personnel, support service industries, and users. This system provides a number of services, including: supporting the waterborne movement of foreign and domestic cargo; moving passengers and vehicles through numerous ferry systems; serving recreational boating, commercial fishing vessels, and cruise liners; and generating millions of jobs for Americans and for the nation's international trading partners. The U.S. marine transportation system also plays an important national security role as a point of entry for foreign shipments and a conduit for the movement of military equipment, supplies, and personnel to and from overseas locations.

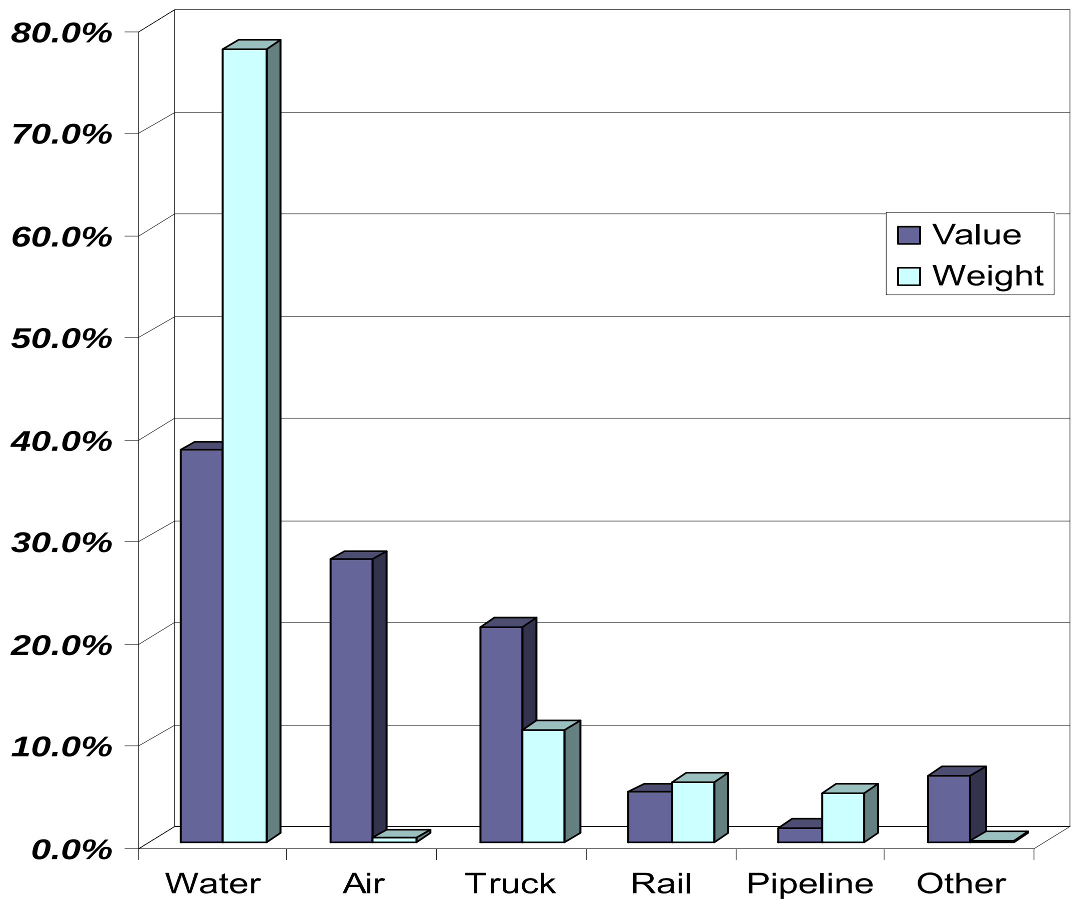
Components of the Marine Transportation System

Each element of marine transportation is a complex system within itself and is closely linked with all the other components. More detailed information about the U.S. marine commerce and transportation sectors is provided in Appendix 5.

Ports

The nation's marine, Great Lakes, and inland ports are critical components of the overall transportation infrastructure (Figure 13.2). Their efficiency and capacity are essential to U.S. importers, exporters, consumers, and domestic suppliers. The majority of U.S. international marine commerce flows through a relatively small number of ports that have the capacity to accommodate large vessels. Out of a total of 326 ports nationwide, 10 of them handle 85 percent of all containerized ship-borne cargo, with the ports of Los Angeles and Long Beach accounting for nearly 40 percent of all such cargo.[4] Ports in Hawaii, Alaska, and the five U.S. trust territories and commonwealths play a special role because they are the primary economically viable link for the movement of commodities to and from these areas.

Figure 13.2. Ports Are the Primary Gateway for International Trade

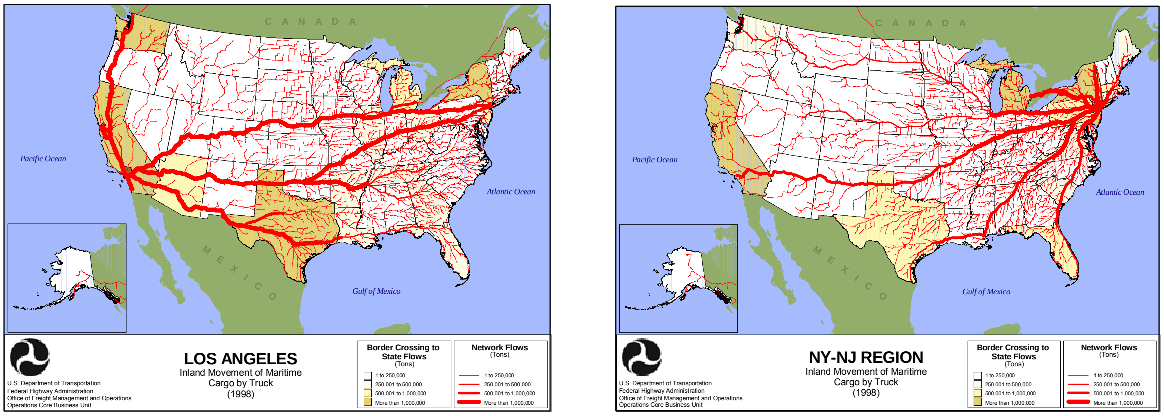


In 2001, U.S. ports were the major portal through which international trade entered and left the country. Marine commerce accounted for 78 percent of total U.S. international trade by weight (1,643 million tons) and 38 percent by value ($718 billion).

Source: U.S. Department of Transportation, Bureau of Transportation Statistics. *U.S. International Trade and Freight Transportation Trends.* Washington, DC, U.S. Government Printing Office. 2003.

With international and domestic marine cargo projected to double over the next twenty years, a key issue will be the ability of the nation's intermodal transportation system—its waterways, railways, highways, and airports—to move cargo into and out of U.S. ports (Figure 13.3). Some of the nation's larger ports are already facing significant obstacles to moving cargo due to inadequate intermodal connections, particularly connections between ports and highways. Complicating this situation is the potentially competing demands being placed on the nation's ports and waterways by passenger ferries, cruise liners, fishing vessels and recreational boating. With the possible exception of fishing vessels, all other marine sectors are expected to continue to show significant growth.

Figure 13.3. Goods Traveling through U.S. Ports are Transported Nationwide



Highways are major arteries for the flow of international freight throughout the United States. As seen in these two maps, the ports of Los Angeles/Long Beach and New York and New Jersey are hubs for the distribution and collection of truck cargo traveling throughout the nation.
Source: U.S. Department of Transportation, Federal Highway Administration. *Freight Analysis Framework*. <http://www.ops.fhwa.dot.gov/freight/Ports%20and%20Border%20Crossings/By%20State.htm> (Accessed January, 2004).

Vessels

Ships entering and leaving U.S. ports include a mix of foreign and U.S.-registered vessels, and a broad variety of vessel types and sizes ranging from large container ships, tankers, and bulk carriers, to medium-sized barges, passenger ferries and cruise liners, and smaller fishing and recreational boats. As the number and size of vessels increase, additional pressures will be placed on the nation's ports and waterways. (For a discussion of issues related to vessel safety and environmental protection, see Chapter 16.)

The vast majority of international trade is carried out using foreign-registered and foreign-crewed vessels that can be operated at considerably lower cost than U.S.-registered vessels crewed by U.S. merchant mariners. The top twenty international merchant fleet nations operate more than 28,000 vessels worldwide. While the United States is ranked fourteenth, its share of the international fleet is only 454 vessels, or about 1 percent of the total. In contrast, the domestic U.S. marine fleet numbers more than 30,000 tugboats, towboats, and barges.[5] The domestic fleet is protected from foreign competition in U.S. waters by the Merchant Marine Act, more commonly known as the Jones Act.

As international marine commerce has grown, ships have grown in size to accommodate increased amounts of cargo. The container ships of the 1960s could carry only a few hundred containers (commonly measured in 20-foot equivalent units, or TEUs). Today, 5,000 TEU vessels are quite common, and the largest container vessels can carry more than 8,000 TEUs, requiring navigation channels up to 50 feet deep. Bulk cargo ships are also increasing in size. For example, ultra-large crude oil carriers, known as super tankers, are approaching lengths of 1,500 feet and widths of 300 feet, requiring channels deeper than 90 feet.[6]

The U.S. marine transportation system also moves millions of passengers every year on cruise liners and ferries. The cruise industry has experienced constant growth worldwide since 1980. Globally, there were more than nine million cruise passengers with a little more than 70 percent, or 6.4 million passengers, embarking from U.S. ports in 2002 (Chapter 16, Figure 16.1), and 176 U.S. and foreign flag cruise ships operated in the North American cruise industry.[7] This annual growth rate of just over 8 percent is expected to increase as the demand for cruise vacations grows.

The 168 U.S. passenger ferries, operating in thirty-five states, transported nearly ninety million people for work, leisure, and other purposes in 1999.[8] Continued population growth in coastal metropolitan areas, coupled with increased vehicle traffic on the nation's highway systems, makes commuter passenger-vehicle ferries attractive transportation options for the future in selected areas. The U.S. passenger ferry industry has shown consistent growth, largely because coastal municipalities and states have invested in ferry systems to ease highway congestion.

Shipbuilding and Repair

Shipbuilding in the United States has historically been considered a strategic industry, supporting both military and commercial interests. Despite this important domestic role, the U.S. shipbuilding and repair industry is in serious decline. Employment is about 50 percent of what it was in the early 1980s, and companies have had to consolidate to survive.

Currently, the U.S. shipbuilding and repair industry consists of about 250 private companies and five publicly owned and operated repair yards.[9] In 2002, the United States had only twenty-four major commercial shipbuilding yards capable of building vessels over 122 meters in length, and only nine of these were actively building ships.[10] Combined, they accounted for only about 1.5 percent of total world ship tonnage on order that year.[11] Much of the U.S. commercial shipbuilding and repair industry works in niche markets, building and repairing mid-sized vessels including ferries, offshore oil and gas supply boats, research and patrol boats, small to mid-size container ships, tugboats, towboats, barges, fishing boats, luxury yachts, and U.S. military vessels. Although high operating costs prevent the U.S. shipbuilding and repair industry from being competitive internationally, the Jones Act insulates the U.S. industry from foreign competition on contracts related to the U.S. domestic and military fleets.

Navigational Aids

Aids to navigation—including buoys, warning lights, maps and charts, hydrographic and environmental data, and communications, positioning, and control systems—are essential to the protection of life and property and the enhancement of marine efficiency, especially as the number of larger and faster vessels visiting U.S. ports increases. Particularly important are recent advances in highly accurate and dependable navigation technology that have revolutionized safe marine passage, including harbor approaches and entrances, and avoidance of shallow water, bottom obstacles, and other vessels. Today's satellite-based global positioning system enables a wide range of mariners to plot a course within a few yards of their actual position. In addition, the National Oceanic and Atmospheric Administration (NOAA) has developed a suite of electronic navigational charts that incorporate global positioning information with high-accuracy data, such as real-time tide and current display capabilities for major U.S. ports and harbors. These charts are especially useful to mariners in meeting real-time navigation requirements to avoid collisions and groundings and in determining the best delivery routes.

Harbors, Channels, and Waterways

The nation's network of harbors, channels, and intracoastal and inland waterways is a vital component of both the U.S. marine transportation system and the overall U.S. intermodal infrastructure. In addition to providing corridors for international trade, this network links U.S. inland ports with coastal and Great Lakes ports, enabling the waterborne movement of domestic cargo, much of which is destined for the international market.

Dredging harbors, channels, and waterways to maintain and increase water depth and to widen and lengthen channels to accommodate wider and deeper-draft ships is critical for the successful operation of the nation's ports. In 2001, the federal government spent $868 million on dredging projects to maintain and deepen the nation's harbors and channels.[12] (See Chapter 12 for a discussion of the complex issues associated with dredging and other sediment management projects.)

Personnel

The U.S. marine transportation system requires a highly skilled and diverse workforce to handle increasingly computerized equipment and vessels, sophisticated electronic navigational aids, and new port technology for the movement of cargo. The U.S. Merchant Marine Academy, the six state-operated marine academies, and other marine education and training facilities in the United States offer training that covers virtually all facets of the U.S. marine transportation system, including at-sea ship operations, port management, marine business, marine, facilities and environmental engineering, and marine safety and environmental protection. As the U.S. system becomes more complex, training requirements will increase. In this area as in many others, the nation should be positioned to meet the demand for the highly skilled workforce of the future.

POSITIONING THE U.S. MARINE TRANSPORTATION SYSTEM FOR THE FUTURE

For the nation's marine transportation system to meet current and future demands, ongoing maintenance, improvement, and expansion will be required. A key prerequisite for a robust system is better coordination, planning, decision making and allocation of resources at the federal level. In particular it will be essential to enhance the connections between this system and other modes of transportation, such as highways, railways, and airports. At the same time, in moving toward an ecosystem-based management approach, planning for the movement of cargo and passengers should be coordinated with the management of many other ocean and coastal uses and activities, and with efforts to protect the marine environment.

Federal Roles

Within the federal government, responsibility for marine commerce and transportation is spread among numerous agencies, primarily the U.S. Department of Transportation (DOT), U.S. Coast Guard, U.S. Army Corps of Engineers, NOAA, U.S. Customs Service, and U.S. Environmental Protection Agency. These agencies have many roles, including vessel traffic management, national security, marine safety, waterway maintenance, environmental protection, and customs.

In 2004, a National Research Council (NRC) report concluded that federal responsibilities for the marine transportation system are highly dispersed, decentralized, and poorly coordinated and do not mesh well with the structure and function of such system.[13] Unlike the highway system, which is primarily the responsibility of DOT's Federal Highway Administration, and the U.S. aviation system, which is the responsibility of DOT's Federal Aviation Administration, the marine transportation system does not have a clearly defined lead federal agency. Statutory, regulatory, and policy differences among federal agencies with roles in marine transportation lead to fragmentation, competition, and in some cases, an inability to work collaboratively due to conflicting mandates. The NRC report was based on an analytical framework that examined four key federal interests: safety, security, commerce, and environmental protection. Federal policy makers can use this framework to identify critical needs within the system and target efforts to meet those needs most efficiently.

National leadership and support will be needed to achieve better integration within the federal government, better links with the rest of the nation's transportation infrastructure, and coordination between marine transportation and other important ocean and coastal uses and activities. The logical agency to assume this responsibility, as it does for the highway, aviation, and railway systems, is DOT.

Recommendation 13-1. Congress should designate the U.S. Department of Transportation (DOT) as the lead federal agency for planning and oversight of the marine transportation system and DOT

should submit regular reports on the condition and future needs of the system. The National Ocean Council should identify overlapping functions in other federal agencies and make recommendations concerning the advisability of transferring those functions to DOT.

Even with one clearly mandated lead federal agency, coordination will be needed among the federal and non-federal participants in the marine transportation system, given the significance of domestic and international trade to the nation and the complexity of the components that make up the system. In an effort to address this, eighteen federal agencies with responsibilities for various aspects of the U.S. marine transportation system signed a memorandum of understanding in 2000 that created the Interagency Committee for the Marine Transportation System.[14]

Federal Members of the Interagency Committee for the Marine Transportation System

U.S. Coast Guard	Federal Highway Administration
Maritime Administration	Federal Transit Administration
U.S. Army Corps of Engineers	Bureau of Transportation Statistics
National Oceanic and Atmospheric Administration	Research and Special Programs Administration
U.S. Navy	U.S. Air Force
U.S. Environmental Protection Agency	St. Lawrence Seaway Development Corp.
National Geospatial-Intelligence Agency	U.S. Department of Agriculture
U.S. Customs Service	Minerals Management Service
Federal Railroad Administration	Bureau of Export Administration

The committee's goal is to enhance information exchange among the member agencies; its safety, security, and environmental subcommittees also serve as forums for the resolution of shared issues. However, the ability of the committee to engage in more substantive policy or budgetary planning is very limited. To become more effective, the responsibility and accountability of the committee will need to be elevated.

Recommendation 13–2. Congress should codify the Interagency Committee for the Marine Transportation System and place it under the oversight of the National Ocean Council.

The Committee should:

- *be chaired by the U.S. Department of Transportation.*
- *improve coordination among all participants in the U.S. marine transportation system.*
- *promote the integration of marine transportation with other modes of transportation and with other ocean and coastal uses and activities.*
- *recommend strategies and plans for: better informing the public of the importance of marine commerce and transportation; devising alternate funding scenarios to meet short- and long-term demands on the marine transportation system; matching federal revenues derived from marine transportation with funding needs to maintain and improve the system; and delineating short- and long-term priorities.*

Because marine transportation involves many actors outside the federal government, the Marine Transportation System National Advisory Council was created to serve as a forum for coordination among nonfederal participants in the marine transportation system and a venue for providing input to the federal government on important national issues.

Nonfederal Member Organizations of the Marine Transportation System National Advisory Council	
American Association of Port Authorities	National Association of Regional Councils
American Great Lakes Ports Association	National Association of Waterfront Employers
American Maritime Congress	National Governors Association
American Pilots' Association	National Industrial Transportation League
American Trucking Associations	National Mining Association
Association of Metropolitan Planning Organizations	National Waterways Conference
Boat Owners Association of the U.S. (BOAT US)	North American Export Grain Assoc., Inc.
Chamber of Shipping of America	Pacific Maritime Association
Conference of Minority Transportation Officials	Passenger Vessel Association
Inland Rivers, Ports and Terminals, Inc.	Shipbuilders Council of America
International Longshore and Warehouse Union	The Ocean Conservancy
International Longshoreman's Association	U.S. Chamber of Commerce
INTERTANKO	U.S. Exporters Competitive Maritime Council
Maritime Security Council	United States Maritime Alliance, Ltd. (USMX)
MIT Center for Transportation Studies	World Shipping Council

This nonfederal advisory council should be maintained and have direct advisory links to the National Ocean Council as well as to DOT where its charter resides. This body could be very helpful in improving collaborations between coastal management programs and the transportation planning and priority setting process.

Links to the National Transportation Infrastructure

An important step in allowing the U.S. marine transportation system to grow, while minimizing increased congestion, delays, and costs to U.S. businesses and consumers, is to improve the movement of cargo into and out of ports. Existing intermodal connections are inadequate to meet the expected increase in foreign and domestic trade. The nation's transportation infrastructure is largely an agglomeration of competing transportation modes, each focusing on its own priorities. While this approach has produced an extensive infrastructure, a national strategy is needed to enhance the connections among these modes, including the nation's ports, and ensure greater overall effectiveness.

Recommendation 13–3. The U.S. Department of Transportation should draft a new national freight transportation strategy to support continued growth of the nation's economy and international and domestic trade. This strategy should improve the links between the marine transportation system and other components of the transportation infrastructure, including highways, railways, and airports. Based on the new strategy, investments should be directed toward planning and implementation of intermodal projects of national significance.

In developing the national freight transportation strategy, DOT should emphasize strategic planning with states, regions, and the public sector as is already being carried out for the U.S. highway system.

The movement of cargo by inland and coastal waterways, known as short sea shipping, is an emerging mode of transporting cargo. Significant increases in short sea shipping between U.S. ports would help to alleviate highway and landside port congestion by decreasing the volume of truck and railway cargo entering and leaving U.S. ports. It would also serve to bolster the U.S. shipbuilding industry and the U.S. Merchant Marine as demand increased for U.S. port-to-port conveyance.

Recommendation 13-4. The U.S. Department of Transportation should conduct a thorough analysis and assessment of the potential societal and economic benefits of increased short sea shipping.

Information Needs

Planning for the future of the U.S. marine transportation system requires accurate and timely information, including estimates of the volume of current and future cargo transportation, their origins and destinations, and the capacity of the various transportation modes. Such information is essential to understand the strengths and weaknesses of the current system and the challenges and opportunities for improving its effectiveness. Transportation planners and coastal managers also need better information to improve connections between marine and landside transportation systems and to improve the overall management of the wide range of interrelated ocean and coastal uses and activities that includes the marine transportation system.

Recommendation 13–5. The U.S. Department of Transportation (DOT), working with other appropriate entities, should establish a national data collection, research, and analysis program to provide a comprehensive picture of freight flows in the United States and to enhance the performance of the nation's intermodal transportation system. DOT should periodically assess and prioritize the nation's future needs for ports and intermodal transportation capacity to fulfill the needs of the nation's expected future growth in marine commerce.

The freight information collection program should include:

- *economic models that project trade and traffic growth and determine the impacts of growth on U.S. ports and waterways and the inland infrastructures connected to them.*
- *models and guides to identify bottlenecks and capacity shortfalls.*
- *consistent, nationally accepted definitions and protocols for measuring capacity.*
- *innovative trade and transportation data collection technology and research to fill critical data gaps.*
- *assessment of the social and economic ramifications of marine transportation investments as compared to other transportation investments.*

Emergency Preparedness

Natural disasters, labor disputes, terrorist attacks, ship collisions, spills of hazardous materials, and many other human and naturally caused events can disrupt the flow of marine cargo and passenger services, causing severe economic and social ramifications nationally and internationally. Diminished port capacity might also affect vital military operations. A strategic scenario of a terrorist event conducted in 2002 demonstrated the potential for $60 billion in losses in the case of a twelve-day closure of all ports in the nation.[15]

Labor disputes can also present significant interruptions in port operations. A ten-day lockout of workers at twenty-nine West Coast ports in October 2002 caused an estimated $15.6 billion in losses to the national economy, and demonstrated the cascading consequences of a major port shutdown.[16]

Port Security

In the wake of the September 11, 2001 attacks, a major challenge has arisen to increase security at the nation's ports, including enhanced control of the six million imported containers and many hazardous cargo tank ships that move through U.S. ports annually. The U.S. Department of Homeland Security is coordinating extensive efforts to address port security, including the development of a National Maritime Transportation Security Plan, area-based security plans, and requirements for certain vessels and port facilities to conduct security threat assessments, develop security plans, designate security officers, perform drills, and take appropriate preventive measures.

Ship Collisions and Groundings

Ship collisions, groundings, and other types of underwater obstructions in and near ports can cause port closures, particularly when safe navigation is impeded. Cleanup operations in response to spills associated with such incidents may complicate the restoration of traffic flow. Further constraining the ability to plan for and respond to such problems is the lack of adequate salvage capabilities nationwide.

Natural Disasters

There are many historical examples of natural disasters—such as hurricanes, earthquakes, tsunamis, and droughts—affecting safe navigation and port operations. A 1994 tropical rainfall in Houston, Texas, caused the closure of the Houston Ship Channel for several days due to flooding, dangerous currents, pipeline breaks and fires, shoaling, and channel obstructions. Similarly, in September 2003, Hurricane Isabel forced closures and limited operations at major ports and shipping channels along the mid-Atlantic coast over the period of a week.

Escalating traffic flow combined with the increased potential for emergency port closures call for enhanced emergency preparedness and improved contingency planning for U.S. ports.

Recommendation 13–6. In developing a national freight transportation strategy, the U.S. Department of Transportation should work closely with the U.S. Department of Homeland Security and the Federal Emergency Management Agency to incorporate port security and other emergency preparedness requirements. The strategy should focus on preventing threats to national security and port operations and on response and recovery practices that limit the impacts of such events, including an assessment of the availability of alternative port capacity.

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PART V
CLEAR WATERS AHEAD: COASTAL AND OCEAN WATER QUALITY

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.

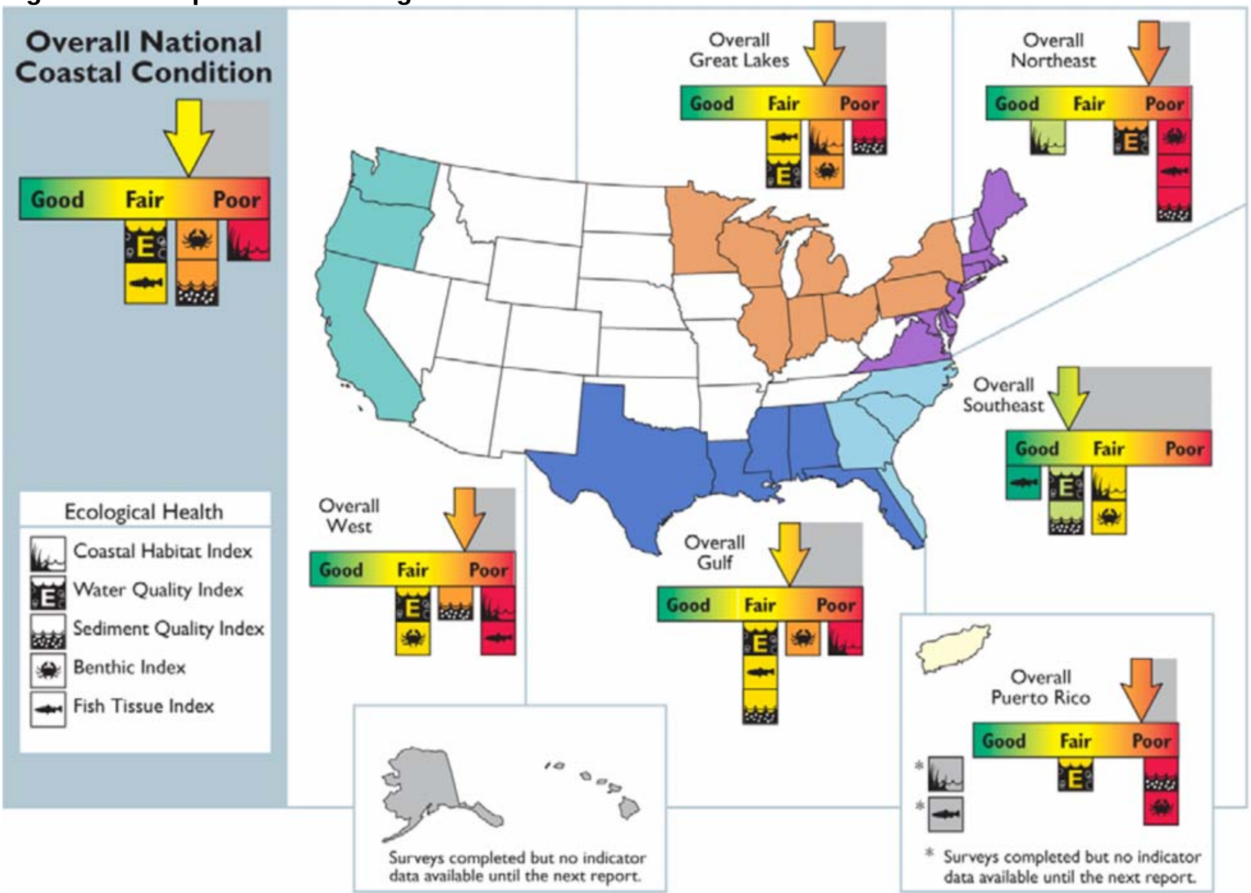
STOPPING THE DEGRADATION OF COASTAL WATERS

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.[1] 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



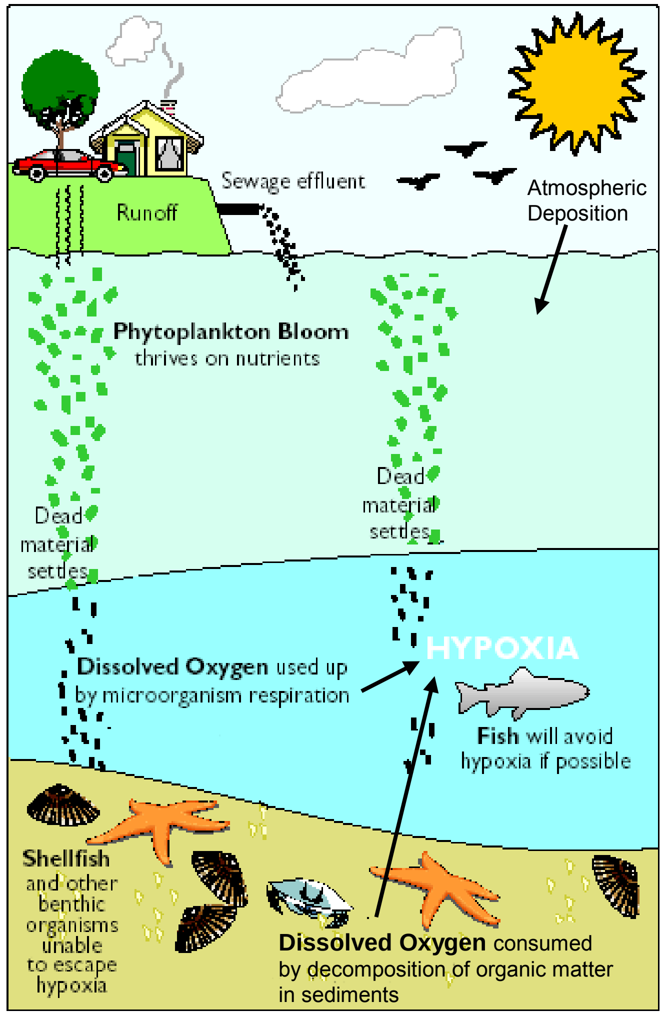
In 2004, six coastal regions of the United States including Puerto Rico were graded based on five environmental indicators. The overall coastal condition of the nation has improved slightly since the last report in 2001, with the Southeast, Gulf of Mexico, and Great Lakes regions showing the largest 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.[2] 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).

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.

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 though the biosphere compared to pre-industrial conditions, with most of this increase occurring during the last thirty years.[3] The largest human additions of nitrogen stem from an increased use of inorganic fertilizers.[4]

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.[5] Without concerted, coordinated, and sustained action to reduce nitrogen sources, nutrient pollution will be a continuing problem in the nation's coastal waters.

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.

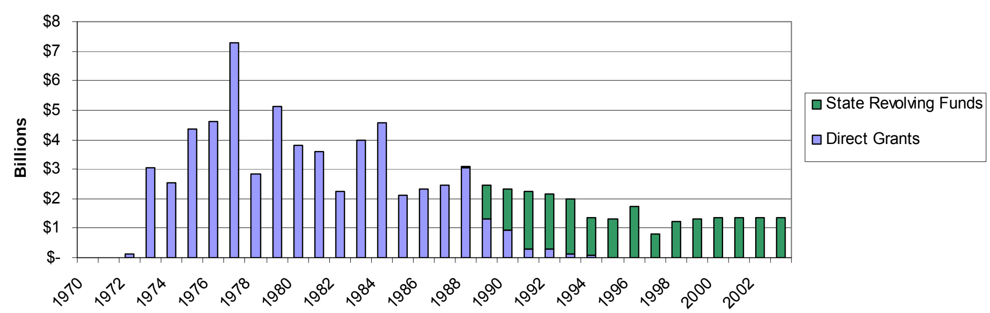
The National Pollutant Discharge Elimination System

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.[6] 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.[7] 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.[8]

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.[9] 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.[10]

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.[11]

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.[12] 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.[13] 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.[14,15] 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.[16] 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.[17]

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

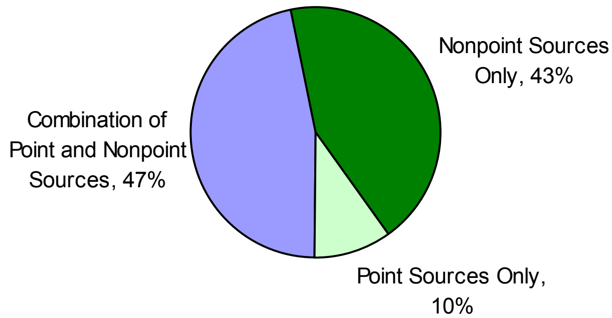
Many major point source facilities are exceeding water pollution permit limits. A significant number of the serious offenders are exceeding pollution limits for toxic substances and many violators have been subject to only light penalties or no enforcement at all. In view of this, there is a strong need 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.[18] 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:

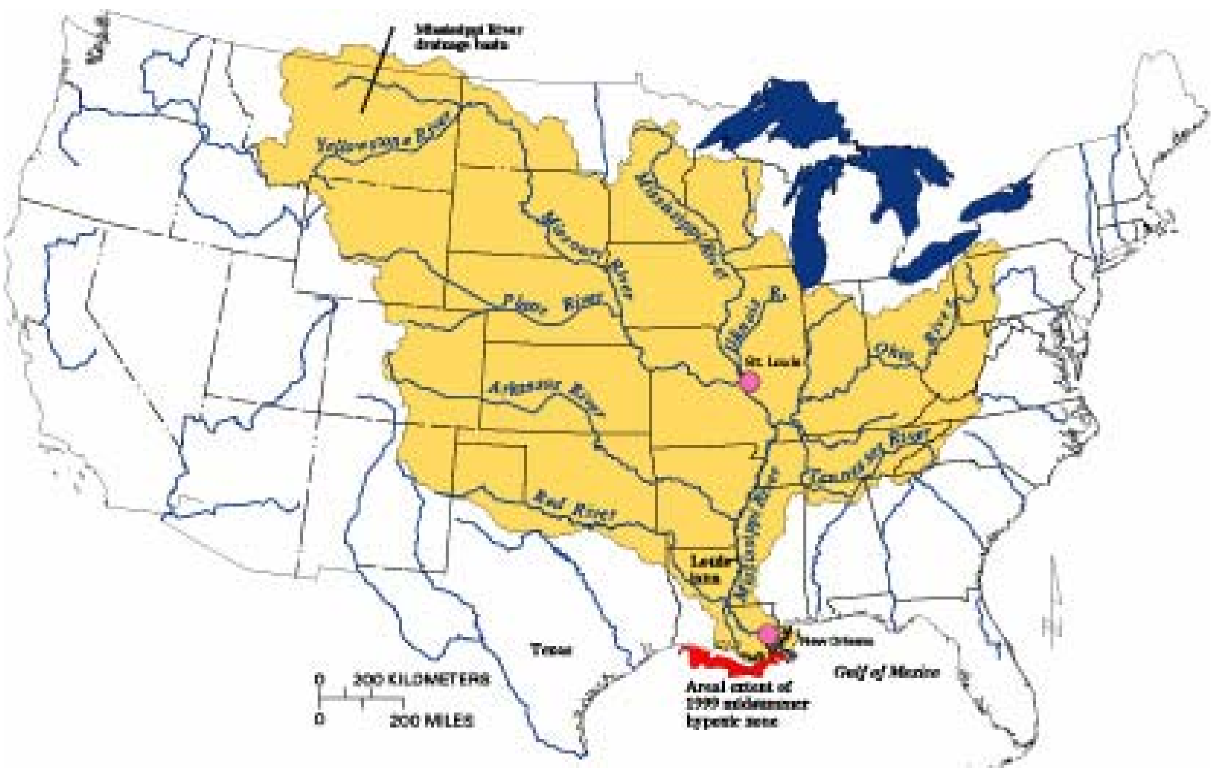
- *require that its state conservationists coordinate with representatives of federal and state water quality agencies and state coastal management agencies, and participate in watershed and coastal management planning processes, to ensure that funding for agricultural conservation programs complements 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. [19] 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 20th 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.[20]

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.[21]

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.[22] 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.[23]

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.[24] 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 H20 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.

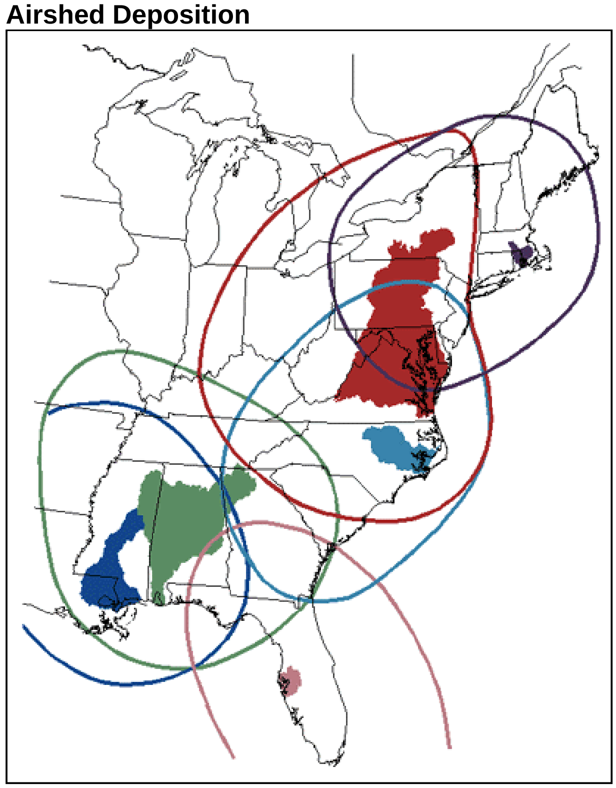
The United States is particularly involved in the coordination, integration, and management of marine pollution programs in the wider Caribbean region, including programs for addressing upstream sources and protecting wetlands, mangrove swamps, coral reefs, and offshore areas. At the 2002 Summit, the 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.[25, 26] 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.[27] 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.

Figure 14.6. Looking Skyward: Accounting for Airshed Deposition



The atmospheric area affecting water quality within a watershed may be ten to several hundred times larger than the watershed itself. As shown here for oxidized nitrogen contributions along the East Coast, the extent of the calculated airsheds illustrate the states, regions, and nations that must coordinate in order to effectively manage atmospheric contributions to water quality.
Source: U.S. Environmental Protection Agency. <http://www.epa.gov/owow/oceans/airdep/air1.html> (Accessed January, 2004).

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.

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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.

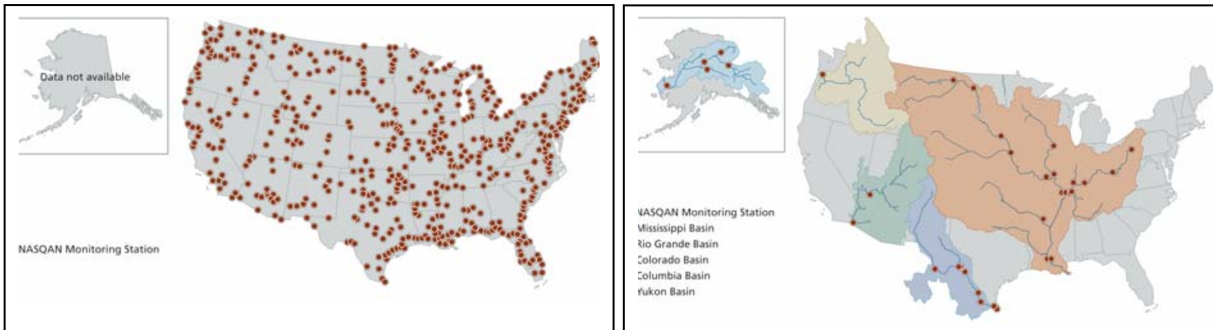
National monitoring has been greatly reduced, particularly in coastal areas, due to funding cuts at USGS and many partner agencies. The USGS National Streamflow Information Program has eliminated a number of stream gages, including long-term gages that are critical for studying climate change. To fully 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.[1]

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



1974-1994

15.1 A. The National Stream Quality Accounting Network program was created in 1974 to develop baseline water chemistry data for the nation. The network started with over 500 stations but by 1994 the program had been reduced to 274 sampling stations throughout the United States. (Not shown are the thirteen stations in Alaska, eight in Hawaii, six in Puerto Rico, and one in Guam.)

2002

15.1 B. Today, the program consists of only thirty-two stations focused on the nation's five major river basins, leaving almost the entire coastal region unmonitored.

Source: U.S. Geological Survey, U.S. Department of the Interior. <http://water.usgs.gov/nasqan/progdocs/index.html> (Accessed January, 2004).

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.[2]

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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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[1] and 9 to 15 percent of its domestic freight.[2,3] The U.S. cruise industry and its passengers generated almost $12 billion in annual spending in 2002,[4] and recreational boaters spend an estimated $30 billion a year.[5] 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.[6] 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.[7] 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.[8] 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[9] and account for 95 percent of passenger ships and 75 percent of cargo ships operating in U.S. waters.[10] 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.[11]

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.[12,13]

A 2004 by 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.[14] 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.[15] 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.[16]

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.[17]

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.[18]

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.[19] 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.[20]

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.[21]

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

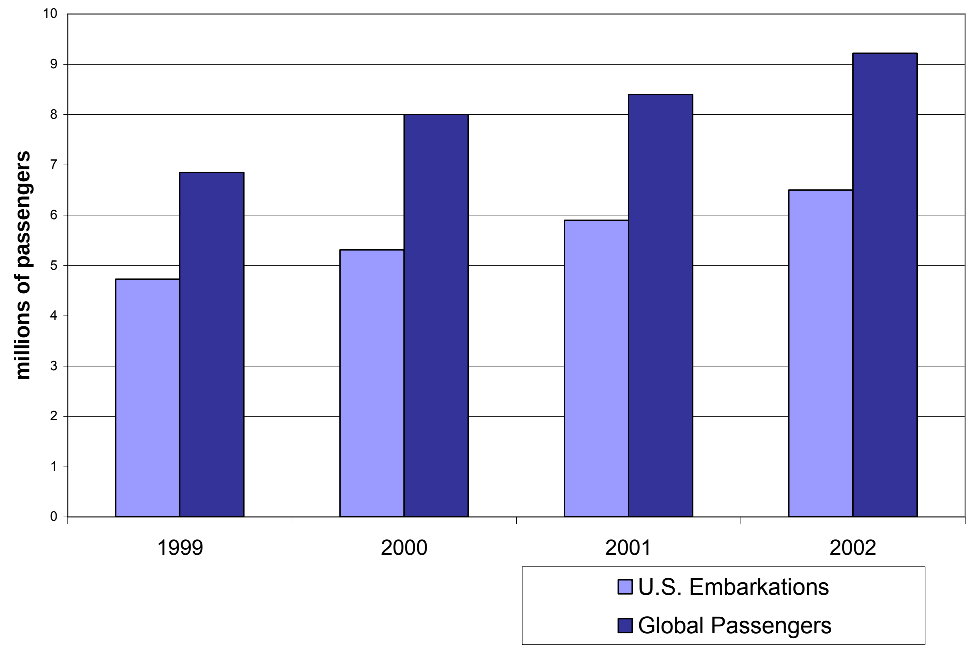
The cruise industry has grown rapidly since the 1980s. By the end of 2002, 176 vessels were operating in the North American cruise industry, and U.S. ports handled 6.5 million cruise embarkations, an increase of over 10 percent from 2001.[22] While growth is expected to slow somewhat over the next several years, double-digit growth is predicted to continue in the near term.[23] 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).[24]

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.[25,26] 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[27] 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.[28] 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.[29] 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.[30] 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.[31]

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.[32] 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,[33] 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.[34] 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.[35] 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.[36] 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).[37]

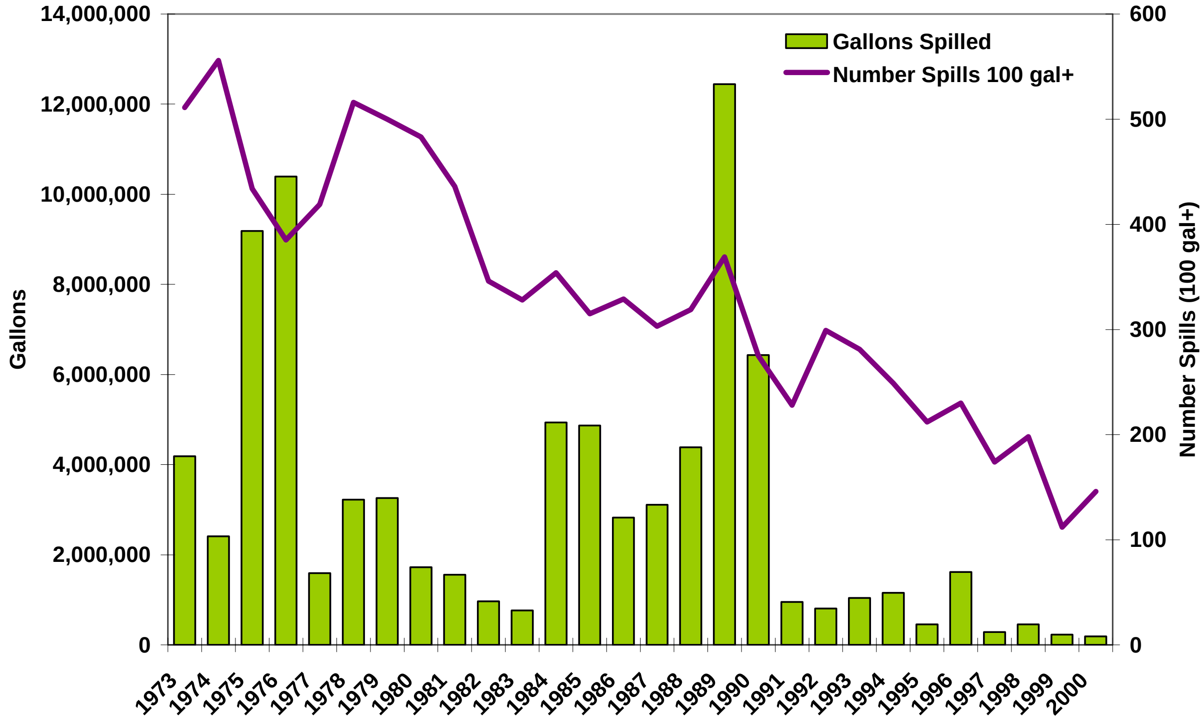
While barge spills have also declined dramatically in the last decade, a 2002 National Research Council report indicated that between 1990 and 1999 the amount of oil released into U.S. waters from barge spills, particularly from spills of heavy distillates, exceeded spills from other vessel sources,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

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.[39] 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.[40] 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."[41] 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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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,[1] and can contribute substantially to altering the abundance, diversity, and distribution of many native species.[2] 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.[3] 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,[4] while less than 1 percent of federal spending in 2000 was allocated to combating aquatic species.[5] 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,[6] 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.

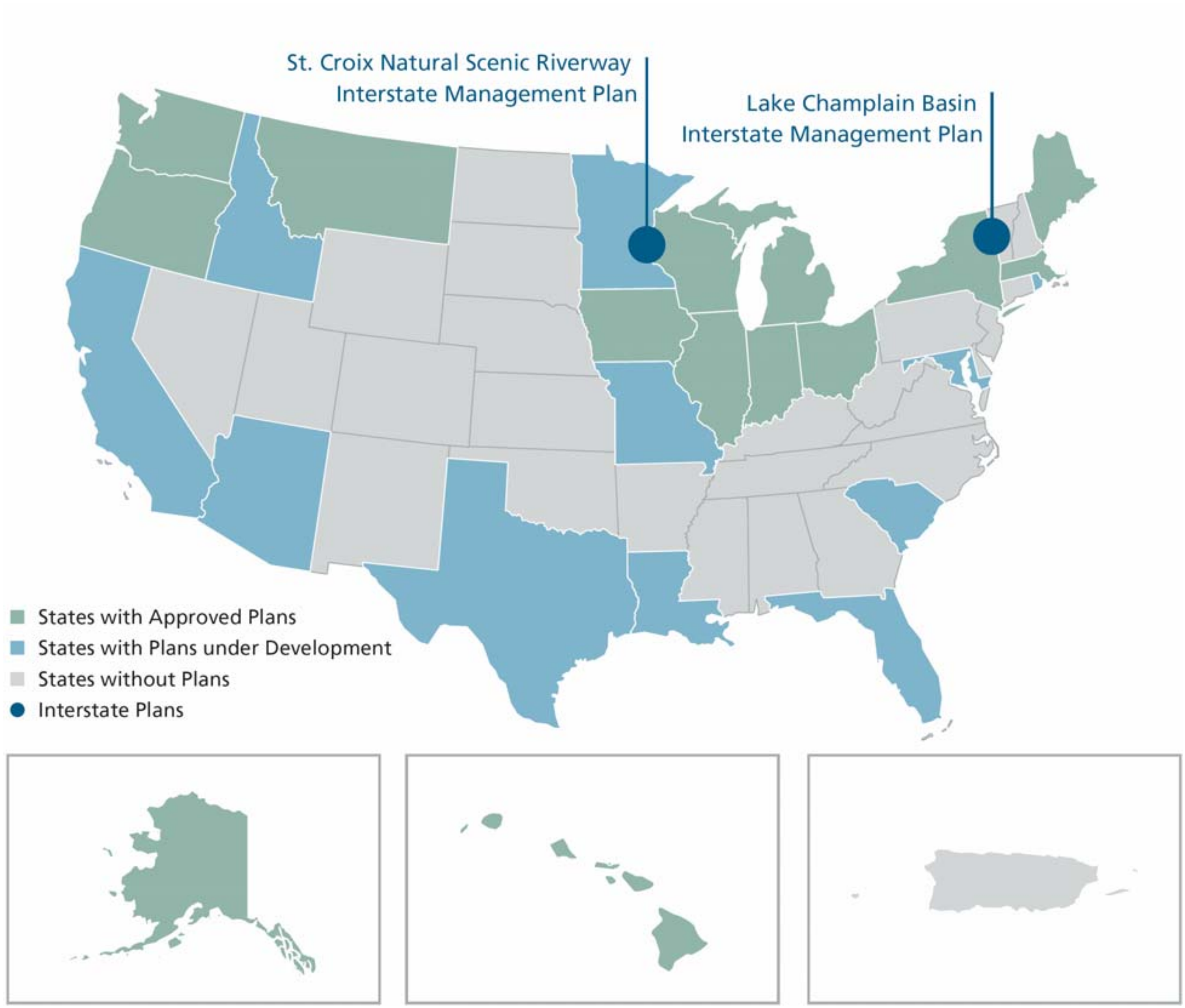
Federal Statutes

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

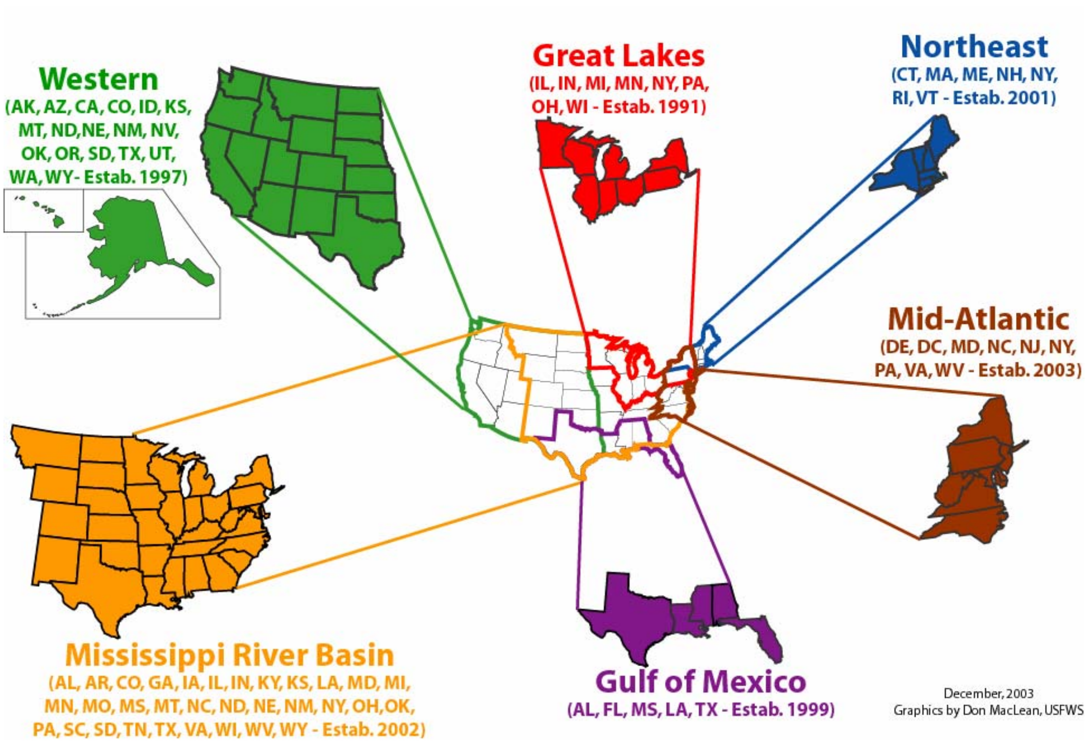


The Aquatic Nuisance Species Task Force encourages states to develop management plans for detecting and monitoring aquatic nuisance species, educating the public, and encouraging collaborative mitigation efforts. However, only fourteen states currently have plans approved by the task force. Most coastal 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



Created under the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, six regional panels work to limit the introduction, spread, and impacts of aquatic nuisance species in their waters.
Map courtesy of U.S. Fish and Wildlife Service, Arlington, VA.

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.[7]

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.[8]

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.[9] 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.[10]

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.[11] 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.[12]

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.[13] 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.[14]

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. [15]

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.*

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Chapter 18:
Reducing Marine Debris

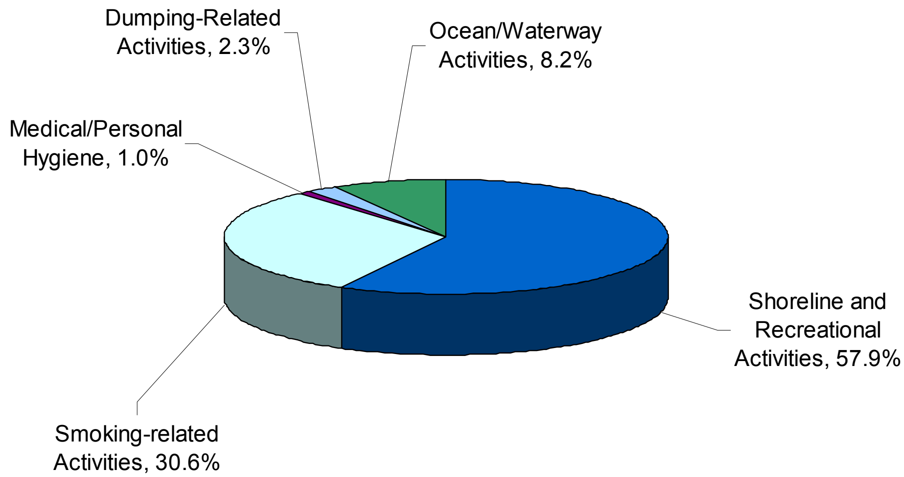
The trash and other waste that drifts around the global ocean and washes up on the nation's shores poses a serious threat to fishery resources, wildlife, and habitat, as well as human health and safety. Marine debris is difficult to address because it comes from a wide variety of sources, both on and 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.[1]

Shoreline and recreational activities were sources of the majority of debris found during the 2002 International Coastal Cleanup (Figure 18.1).[2] 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.[3] 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.[4] 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.[5]

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.[6] 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 $l 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.[7] 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.[8] 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.[9]

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[10] and about 90 percent of debris found floating in the water.[11] 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.[12] 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.[13] 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.

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[7] National Research Council. *Clean Ships, Clean Ports, Clean Oceans: Controlling Garbage and Plastic Wastes at Sea*. Washington, DC: National Academy Press, 1995.
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[9] Ibid.
[10] U.S. Department of Commerce and U.S. Navy. *Turning to the Sea: America's Ocean Future*. Washington, DC, September 1999.
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[12] National Research Council. *Clean Ships, Clean Ports, Clean Oceans: Controlling Garbage and Plastic Wastes at Sea*. Washington, DC: National Academy Press, 1995.
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Part VI
Ocean Value and Vitality: Enhancing the Use and Protection of Ocean Resources

Chapter 19:
Achieving Sustainable Fisheries

The current fishery management regime's emphasis on local participation, coupling of science and management, and regional flexibility are laudable. Nevertheless, the last thirty years have witnessed overexploitation of many fish stocks, degradation of habitats, and negative consequences for too many ecosystems and fishing communities. To ensure the long-term sustainability of U.S. fisheries, maximize social and economic benefits, and reinforce the principle that living marine resources are held in public trust for the benefit of all U.S. citizens, fishery management must be improved. While ultimately the management of fisheries should move toward a more ecosystem-based approach, specific reforms can produce some immediate improvements. These include increasing the role of science by separating allocation and assessment, better integration of ecosystem science, data collection, and processing with management and enforcement, and exploring the use of dedicated access privileges. Finally, improved regional coordination and planning will help put fishery management in the broader context of ocean and coastal management.

Contemplating Thirty Years of Fishery Management

When the Stratton Commission report was released in 1969, marine fisheries were largely unregulated and coastal states had primary responsibility for fishery management. The U.S. fishing industry was behind much of the world both in harvesting fish and technical sophistication. Distant fishing nations, such as the then Soviet Union, Spain, and Japan, dominated harvests on the coasts of North America, fishing just outside the 3 nautical mile limit of U.S. territorial waters.

But fishery harvests around the world were increasing in the 1960s, and many people believed they would continue to increase indefinitely. The Stratton Commission predicted that enhanced technology and intensified exploitation of new species could eventually increase worldwide landings from 60 million metric tons in 1966 to 440–550 million tons.[1] That Commission saw fisheries as an area of immense opportunity, and called for the expansion of U.S. fishing capability. Unfortunately, events over the next few decades showed these predictions to be overly optimistic.

In 1970, landings of Peruvian anchoveta, the largest fishery in the world, fell by 10 million metric tons in one year—at the time, roughly 10 percent of world fishery landings.[2] Although El Niño conditions in the Pacific Ocean are often cited as the cause, many scientists believe the collapse was exacerbated by excessive fishing effort. The following two decades also saw the North Atlantic cod fisheries drastically decline; in the 1990s, Canada completely shut down its cod fishery. Instead of being able to expand worldwide fish landings by eight to ten times, as predicted by the Stratton Commission, it now appears that fish landings were already at or near their peak in the late 1960s.

In 1976, Congress approved the Magnuson–Stevens Fishery Conservation and Management Act (hereinafter, the Act or the Magnuson-Stevens Act) to manage and assert U.S. control over fishery resources within 200 nautical miles of the coast, later designated as the U.S. exclusive economic zone (EEZ). Eight Regional Fishery Management Councils (RFMCs) were created to develop management plans for fisheries in federal waters. The Act required regional plans to be consistent with broad national guidelines, such as the prevention of overfishing and the requirement to use the best available science, but otherwise granted considerable flexibility to the RFMCs. The Act mistakenly assumed that once foreign fishing fleets were removed from U.S. waters, major fishery management problems would be over.

In subsequent years, the domestic fishing industry rushed to enlarge its capacity to catch fish. New technologies were developed while programs such as the Capital Construction Fund and Fishing Vessel Obligation Guarantee Program provided incentives for U.S. fishermen to upgrade or buy new vessels. This led to an unprecedented and unforeseen expansion of U.S. fishing power.

Most of the abundant stocks available to be caught by American fleets were in the North Pacific. In other areas, fish stocks—although still viable—had already been depleted by foreign fleets. The regional flexibility that had been seen as a great strength of the new law now showed its downside as some RFMCs set unsustainable harvest levels, leading to the collapse or near-collapse of several important fisheries.

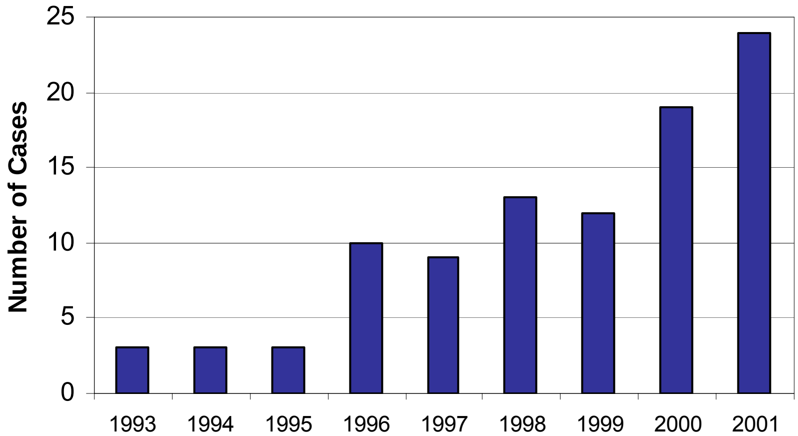
Another unforeseen and unfortunate consequence of the new management regime was the development of an adversarial relationship between fishermen and government scientists and managers. Because assessments indicated that many stocks were already depleted, scientists urged reductions in catches. Many fishermen however, having made substantial capital investments in boats and gear, resisted these findings and instead raised doubts about the credibility of the assessments. The RFMCs frequently made decisions that supported the fishermen by downplaying scientific advice and increasing catch limits. As a result, in most regions, stocks continued to decline throughout the 1980s.

Contention grew, and the 1990s were characterized by a dramatic increase in litigation, crisis-driven decision making, and management through court orders and congressional intervention (Figure 19.1). As of January 2002, more than 110 lawsuits were pending against the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS). And between 1990 and 2000, the National Research Council conducted ten studies aimed at resolving disputes in fishery management.

On a more positive note, the 1990s also witnessed some signs of recovery. Atlantic striped bass were declared recovered in 1995, many New England groundfish species began to come back, and summer flounder stocks in the Mid-Atlantic started to increase.

A 2002 study by the National Academy of Public Administration concluded that the U.S. fishery management system was in disarray and recommended that the U.S. Commission on Ocean Policy explore the need for major changes in the fishery management system. [3] While amendments to the Magnuson–Stevens Act have helped reverse fishery declines, additional changes will be necessary to manage fisheries in a sustainable manner over the long term.

Figure 19.1. Fishery Litigation Grows as Interests Clash



From 1993 to 2001, the number of cases brought against the National Marine Fisheries Service increased eight fold. A major cause of new cases during this time was disputes about the validity of stock assessments and resulting catch limits.

Source: National Academy of Public Administration. *Courts, Congress, and Constituencies: Managing Fisheries by Default*. Washington, DC, July 2002.

Building Sustainable Fisheries Based on Sound Science

The Value of Science for Wise Management

Accurate, reliable science is critical to the successful management of fisheries. Two kinds of data are collected to support fisheries science. *Fishery-dependent* data are collected as part of normal fishing activities and include recreational and commercial catch and landings records, dealer reports, and onboard observer data. Observers on fishing vessels provide a variety of useful fishery-dependent data concerning harvest methods and the bycatch of fish and prohibited species, such as turtles and marine mammals. *Fishery-independent* data are collected outside of normal fishing activities, typically through scientifically-designed surveys conducted by specialized research vessels.

Using available data as input, computer models produce stock assessments that estimate the size and characteristics of a certain fish population. Based on these assessments, and an understanding of the biology of that species, scientists can then predict the effects of different levels of fishing intensity on the population. Fishery managers must then determine how, when, where, and—most importantly—how many fish may be caught.

Although fishery data collection and stock assessment models can always be improved, a lack of adequate scientific information has not been the main culprit in most instances of overfishing. The Mid-Atlantic and New England RFMCs, which managed fourteen of the thirty-three stocks that experienced overfishing in 2001, have some of the best scientific support in the world. A 2002 National Research Council report concluded that the problem in most cases of overfishing was that the RFMCs disregarded or downplayed valid scientific information when setting harvest guidelines.[4] Neither NMFS nor the Secretary of Commerce used their authority to prevent the RFMCs from taking such actions.

The Magnuson–Stevens Act requires each RFMC to establish and maintain a scientific and statistical committee (SSC) to provide "the best scientific information available" and assist in the development of fishery management plans. However, the Act does not require the RFMCs to follow the advice of the SSCs.

Social, economic, and political considerations have often led the councils to downplay the best available scientific information, resulting in overfishing and the slow recovery of overfished stocks. In addition, the selection of SSC members is generally up to each RFMC. No process is in place for ensuring that SSC members have the proper scientific credentials and are free from conflicts of interest. Although some councils do assemble highly respected SSCs and follow their advice, the public and the fishing community should be confident this is the case in all regions.

Recommendation 19–1. Congress should amend the Magnuson–Stevens Fishery Conservation and Management Act and related statutes to require Regional Fishery Management Councils (RFMCs) and interstate fisheries commissions to rely on their Scientific and Statistical Committees (SSCs), incorporating SSC findings and advice into the decision-making process. In keeping with this stronger role, SSC members should meet more stringent scientific and conflict of interest requirements, and receive compensation.

To ensure a strengthened SSC:

- *each RFMC should nominate candidates for service on its SSC. Nominees will typically be scientists with strong technical credentials and experience, selected from federal or state governments or academia. Private sector scientists who are technically qualified may also be nominated if they meet the conflict of interest requirements.*
- *no individual should be allowed to serve on an SSC if he or she is formally or financially affiliated with any harvesting or processing sector.*
- *the National Oceanic and Atmospheric Administration (NOAA) should evaluate the qualifications and potential conflicts of interest of SSC nominees through an independent review process designed by a credible, scientific organization. Ultimately, SSC appointments should be approved by the NOAA Administrator.*
- *SSC members should serve for fixed terms to allow for rotation and new members over time.*
- *like RFMC members, participants in the SSC (or their home institutions) should be compensated for time spent on RFMC business.*

Separating Scientific and Management Decisions

One of the strengths of the U.S. fishery management system is its flexibility in allowing different regions to determine who can fish, as well as how, where, and when. These are called allocation decisions. But the question of how many fish can be sustainably harvested (the assessment decisions) should be insulated from political pressures.

Because of their knowledge of the fisheries and communities in their region, RFMC members are best suited to make decisions about allocation of the available harvest and other issues related to the operations of regional fisheries. However, scientific decisions are more appropriately made by the SSCs created to support the RFMCs. Scientific decisions include stock assessments and determinations of allowable biological catch– the maximum amount of fish that can be harvested without adversely affecting recruitment or other key biological components of the fish population.

While determining allowable biological catch is a scientific question, it must be informed and guided by long-term objectives set by managers for both the fishery and the ecosystem. The role of scientific information should be as strong as possible in fishery management and subject to the least possible political influence.

For this reason, many fishery managers and analysts have recommended separating scientific assessment decisions from the more political allocation decisions. While not required by law, some RFMCs have already taken this step. For example, the North Pacific council has a history of setting harvest levels at or below the level recommended by its SSC. Many policy makers believe this practice is largely responsible for the successful management of the fisheries in that region.

Recommendation 19–2. Scientific and Statistical Committees (SSCs) should be required to supply Regional Fishery Management Councils (RFMCs) with the scientific information necessary to make fishery management decisions. Such information could include reports on stock status and health, socioeconomic impacts of management measures, sustainability of fishing practices, and habitat status. In particular, the SSCs should determine allowable biological catch based on the best scientific information available to them.

Recommendation 19-3. Each Regional Fishery Management Council should be required to set harvest limits at or below the allowable biological catch determined by its Scientific and Statistical Committee. The councils should begin immediately to follow this practice, which need to be codified at the next opportunity in amendments to the Magnuson–Stevens Fishery Conservation and Management Act.

The Need for Independent Review

Independent review is the hallmark of the scientific process, providing assurance that appropriate procedures for data collection and analysis have been used. Typically such reviews are conducted by scientists with expertise similar to those who have done the work; thus the process is called peer review.

Many of those affected by RFMC decisions have questioned the adequacy of the scientific information on which those decisions were based. Although scientific findings are always easier to accept when they bring good news, the lack of a standardized, independent, and transparent review process in all regions has added to the level of distrust. Many of the RFMCs and interstate commissions with management responsibilities currently apply the peer review process sporadically. The North Pacific, New England and Mid-Atlantic regions have long-standing peer review programs. Other RFMCs use an external peer review process only when results are expected to be controversial. In some cases where scientific information is reviewed, the reviewers have not been perceived as independent, a critical feature of the process.

The National Research Council (NRC) has conducted a number of reviews of NMFS science. However, the NRC cannot be called upon to review every scientific decision, particularly stock assessments, at the rate they are generated for the RFMCs. An interesting model for external scientific review is the Center for Independent Experts that was established by NMFS in 1998 to conduct reviews of fisheries-related science. Although NMFS pays for its operation, the center is currently based at the University of Miami and is completely insulated from NMFS once it initiates a peer review. Although the center's experts have examined a number of controversial topics, their reviews have so far been less subject to challenge than internal NMFS peer reviews.

Recommendation 19–4. The National Marine Fisheries Service, working with the Regional Fishery Management Councils and the interstate fisheries commissions, should develop a process for independent review of the scientific information generated by the Scientific and Statistical Committees in all regions.

The process should include three distinct procedures:

- *a standard review, undertaken annually by regional scientists, to ensure that the correct data and models are being used.*
- *an enhanced review to evaluate the models and assessment procedures. To ensure that these reviews are independent, a significant proportion of the reviewers should come from outside the region and be selected by a group such as the Center for Independent Experts. These types of reviews would be conducted on a three- to five-year cycle, or as needed, to help ensure that the latest methods and approaches are being used.*
- *an expedited review to be used when results are extremely controversial or when the normal review process would be too slow. In these cases, all reviewers should be selected by a group such as the Center for Independent Experts.*

As these review procedures are implemented and become a regular part of the fishery management process, NMFS, the RFMCs, and states should be able to develop routine quality assurance steps and standards to be applied to all stock assessments and other scientific input to the fisheries process. A certification procedure for stock assessment scientists will help ensure implementation of these standards.

Using Default Measures to Ensure Progress

The difficult process of establishing allowable biological catch, and then determining allocations based on that figure, can result in lengthy delays in developing or revising fishery management plans. The Magnuson–Stevens Act does not require RFMCs to submit a new or revised plan to NOAA on any specific schedule. As a result, council delays can lead to a fishery having no management measures in place or relying on outdated, inadequate plans. When that happens, the RFMCs are not penalized; instead, the adverse consequences are all borne by the fishery resource. There are two possible sources of delay: SSC difficulties in reaching agreement on allowable biological catch and RFMC delays in submitting management plans to NOAA for approval.

The science behind stock assessments is complex and constantly evolving. By nature and training, many scientists are reluctant to declare a definitive numerical conclusion in the face of inevitable uncertainty. And yet, decisions must be made. By joining an SSC, scientists must accept the necessity of giving the best advice possible within a real-world timeframe.

Delays in formulating management plans within the RFMC can be more intractable. Under the current system, RFMCs can simply avoid difficult decisions by postponing development of plans. While the councils cannot be sued for their slowness, NMFS can be. In fact, an increasing number of lawsuits are prompted by delays in management actions, particularly for plans to end overfishing.

The very possibility of extended delays puts pressure on NMFS to recommend approval of inadequate management plans. Based on a recommendation from NMFS, the Secretary of Commerce may approve, partly reject, or reject a plan, but may not amend it. As part of its recommendation, NMFS is aware that rejection of a plan could result in no conservation measures being in place until the RFMC agrees on a revised plan—a process that could take many months.

Although the Secretary of Commerce can legally choose to develop a fishery management plan within the agency instead of waiting for a regional council to do so, this is almost always impractical. Since Congress clearly desired RFMCs to have the lead in fishery management, the Secretary can either enter into a protracted, contentious, and politicized process to develop a departmental plan, or continue to wait for the RFMC to act. Under either scenario, the resource may remain unprotected for an extended period of time.

Indecision on the part of SSCs or RFMCs, for whatever cause, should not delay measures to ensure the long-term health and economic viability of a fishery. By setting clear deadlines for action, and activating established default measures if a deadline is missed, the roles of the different entities can be maintained without sacrificing the resource.

Recommendation 19–5. Each Regional Fishery Management Council should set a deadline for its Scientific and Statistical Committee (SSC) to determine allowable biological catch. If the SSC does not meet that deadline, the National Marine Fisheries Service Regional Science Director should set the allowable biological catch for that fishery.

Recommendation 19–6. Once allowable biological catch is determined, whether by the Scientific and Statistical Committee or the National Marine Fisheries Service (NMFS) Regional Science Director, the Regional Fishery Management Council should propose a fishery management plan in time for adequate review and approval by NMFS. If the plan is not presented in a timely fashion, all fishing on that stock should be suspended until NMFS can review the adequacy of the management plan.

Making Research Relevant

As noted above, independent reviews have generally concluded that NMFS stock assessment programs are technically sound and highly credible. However, improvements could be made to better serve the RFMCs' information needs, support recreational fisheries, and expand opportunities for cooperative research to involve scientists and fishermen in joint projects.

RFMC Input on Research Priorities

RFMC members need access to reliable information to do their jobs. The NMFS science program has done well in providing biological information to manage single species. However, the research program is less well positioned to answer many other pressing questions.[5] Generally, questions that involve interactions among fisheries, habitat, and other protected species, as well as social science and economic questions, have received less attention than traditional stock assessment science and fishery biology. [6, 7] The move toward ecosystem-based management, including considerations such as essential fish habitat, highlights these shortcomings. As the agency charged with responsibility for federal fishery management, NMFS should ensure that its research agenda supports the information needs of the RFMCs.

Recommendation 19–7. The Regional Fishery Management Councils and their Scientific and Statistical Committees should develop an annual, prioritized list of management information needs and provide it to the National Marine Fisheries Service (NMFS). NMFS should incorporate these needs to the maximum extent possible in designing its research, analysis, and data collection programs.

The lists of RFMC information needs will also be of great value to the regional ocean information programs discussed in Chapter 5, which would be responsible for crafting regional research strategies to meet management needs. Fisheries research and data requirements should also be included as an integral part of planning for the Integrated Ocean Observing System discussed in Chapter 26.

Data Needs for Recreational Fisheries

Recreational fishing is an important part of the culture and economy of many coastal communities. In 2002, an estimated 9.1 million saltwater recreational fishermen spent over $20 billion and supported almost 300,000 jobs.[8]

Recreational fishing has many impacts on fishery resources. On the beneficial side, the increasing number of catch-and-release programs has been associated with helping some stocks recover. In addition, the Ethical Angler program, a voluntary code developed with cooperation between NMFS and constituent groups, promotes a stewardship ethic among recreational fishermen on behalf of the entire marine environment. On the other hand, recreational fishermen can contribute significantly to the overall mortality of certain stocks. For example, in 2001, recreational anglers landed over 19 million pounds of striped bass on the East Coast, three times the amount caught by the commercial sector.[9]

Despite the economic and ecological importance of recreational fishing, much less data are collected in this area than for commercial fisheries. The NMFS Marine Recreational Fisheries Statistics Survey, the primary recreational data collection program, is accomplished using two methods: an intercept survey, where fishermen are interviewed at coastal fishing ports, and a random telephone survey of all coastal households. The telephone survey results could be greatly improved if the sample of individuals called could be drawn from a list of licensed recreational fishermen rather than all coastal households. This would require coastal states and the federal government to require licenses for all saltwater anglers.

Although the existing survey methodology is adequate for long term tracking of recreational fishing trends, it has proven less useful for in-season management. For example, on the East Coast, the lack of in-season tracking of catches by recreational fishermen has led to the chronic overharvesting of summer flounder.[10] Due to the increasing popularity of marine recreational fishing, and its growing proportion of the total catch in some fisheries, it will be critical to collect timely data in this sector to allow for sustainable management of fisheries.

Recommendation 19–8. The National Marine Fisheries Service, working with states and interstate fisheries commissions, should require all saltwater anglers to purchase licenses to improve in-season data collection on recreational fishing. Priority should be given to fisheries in which recreational fishing is responsible for a large part of the catch, or in which recreational fishermen regularly exceed their allocated quota.

The Value of Cooperative Research

Involving fishermen in the research process, referred to as cooperative research, is a promising approach that can produce benefits for the fishermen, the scientists, and ultimately the management process. Underutilized fishing vessels can provide cost-effective research platforms to expand the scope of data gathering and create an additional source of income for fishing communities waiting for stocks to recover. Fishing vessels are usually significantly less expensive to operate than traditional research vessels, while still suitable for many types of research. Scientists can also benefit from the knowledge and experience gained by fishermen during years at sea.

Increased interaction and rapport between fishermen and fishery scientists is another benefit of cooperative research. In many regions of the country, fishermen are skeptical of the science and analysis used to support fisheries management. Until the 1990s, scientists rarely included fishermen in either the design or data collection phases of their research. This has fed the perception in fishing communities that scientists do not understand fishing and do not value the experiences of fishermen. Greater involvement of fishermen in research programs appears to have been successful in reversing this perception and promoting better understanding between fishermen and scientists.

In 1977, when NMFS stock assessments indicated that bowhead whales off Alaska's North Slope were at extremely low levels, the International Whaling Commission proposed a ban on all whaling, including that done for subsistence. The indigenous whaling community, convinced that the assessment had under-counted whales, provided NMFS scientists with additional information on whale locations and migration patterns based on traditional knowledge. The scientists revised their survey protocols to incorporate this new information, determined that they had in fact underestimated the whale population, and allowed the subsistence harvest to continue.

Similarly, in 1999, initial estimates indicated that Atlantic monkfish were severely overfished and a management plan was created to curtail fishing and rebuild the stock. When fishermen contended that the NMFS survey was missing significant stocks of monkfish in deeper waters, NMFS initiated a cooperative research program to investigate. The results indicated that monkfish were indeed present in significant numbers in deeper waters, allowing managers to reduce the severity of catch restrictions.

In both of these examples, anecdotal or traditional information was not unconditionally accepted. Instead, scientists used data from fishermen as the basis for further investigation. Scientists can benefit from fishermen's experience by incorporating their suggestions into the design of research programs. At the same time, fishermen need to realize that informal information can only be used in decision making after it has been tested and verified according to a methodical, scientific process.

Cooperative research has the potential to be applied quite broadly. Although fishery-specific research, particularly experiments with new or modified gear types, is the most obvious application, others should be considered. The RFMC lists of information needs, suggested above in Recommendation 19–6, will be helpful in selecting topics for cooperative research. For example, NOAA should organize its oceanographic research programs to take advantage of cooperative opportunities, as should scientists conducting economic or social science research related to oceans and coasts.

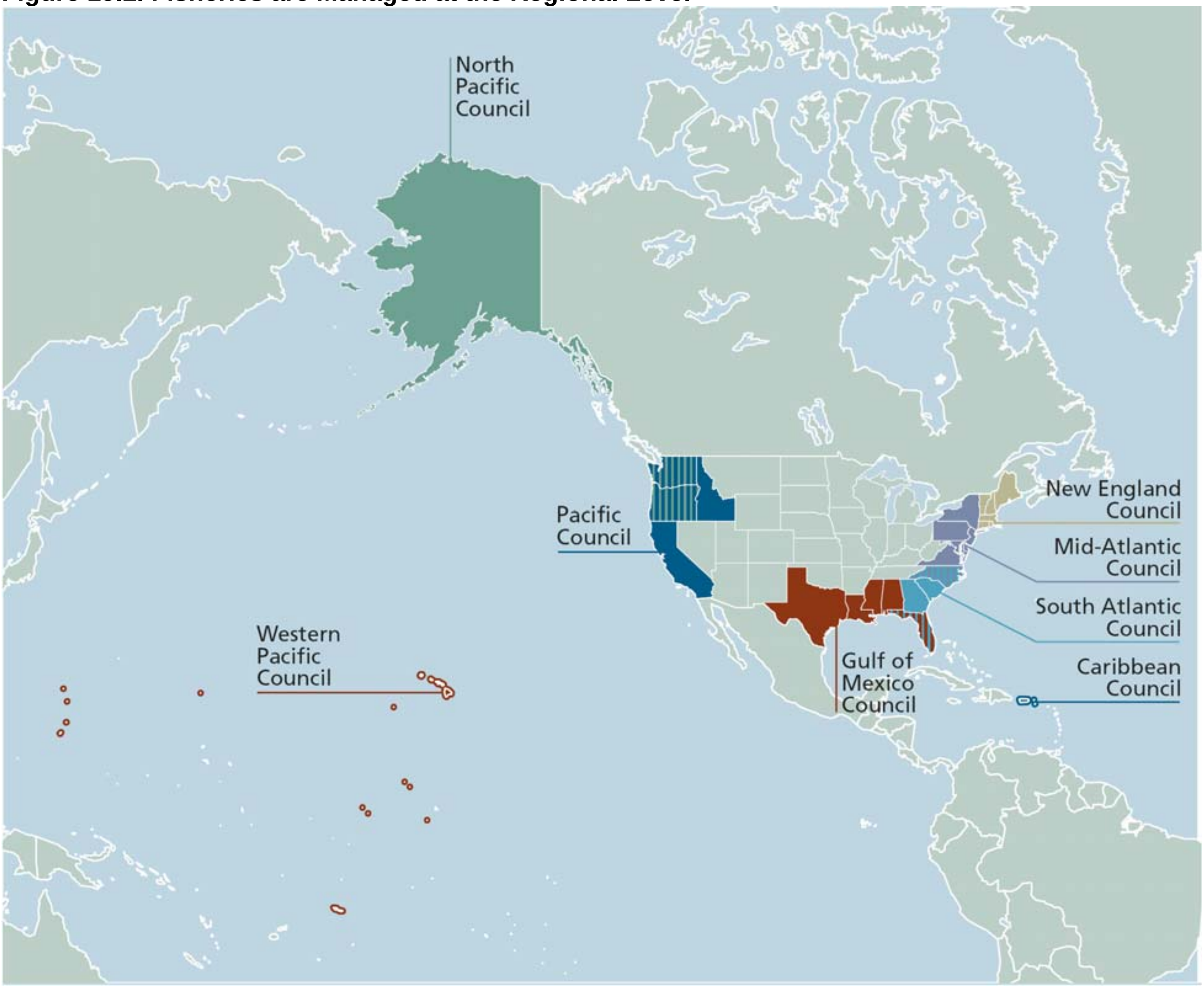
Recommendation 19–9. Congress should increase support for an expanded, regionally-based cooperative research program in the National Oceanic and Atmospheric Administration (NOAA) that coordinates and funds collaborative projects among scientists and commercial and recreational fishermen. NOAA should develop a process for external evaluation and ranking of all cooperative research proposals to ensure the most worthwhile projects are funded, the most capable performers are undertaking the research, and the information produced is both scientifically credible and useful to managers.

Strengthening Fishery Governance

Clarifying Fishery Management Authority and Jurisdiction

In 1976, the Magnuson–Stevens Act greatly expanded the federal government's marine fishery management jurisdiction from the seaward boundary of state waters out to 200 nautical miles from the coast. Known as the Fisheries Conservation Zone, this newly created area was later subsumed into the EEZ. In general, marine fishery management jurisdiction is divided among the states, three interstate fisheries commissions, eight RFMCs, and the federal government. The RFMCs develop management plans for fisheries within their portion of the EEZ (Figure 19.2). Based on advisory group recommendations, NMFS develops and implements plans for highly migratory species (including tuna, swordfish, billfish, and sharks) within the EEZ in the Atlantic, Gulf of Mexico, and Caribbean regions. In the Pacific, the RFMCs or states include highly migratory species in their management plans.

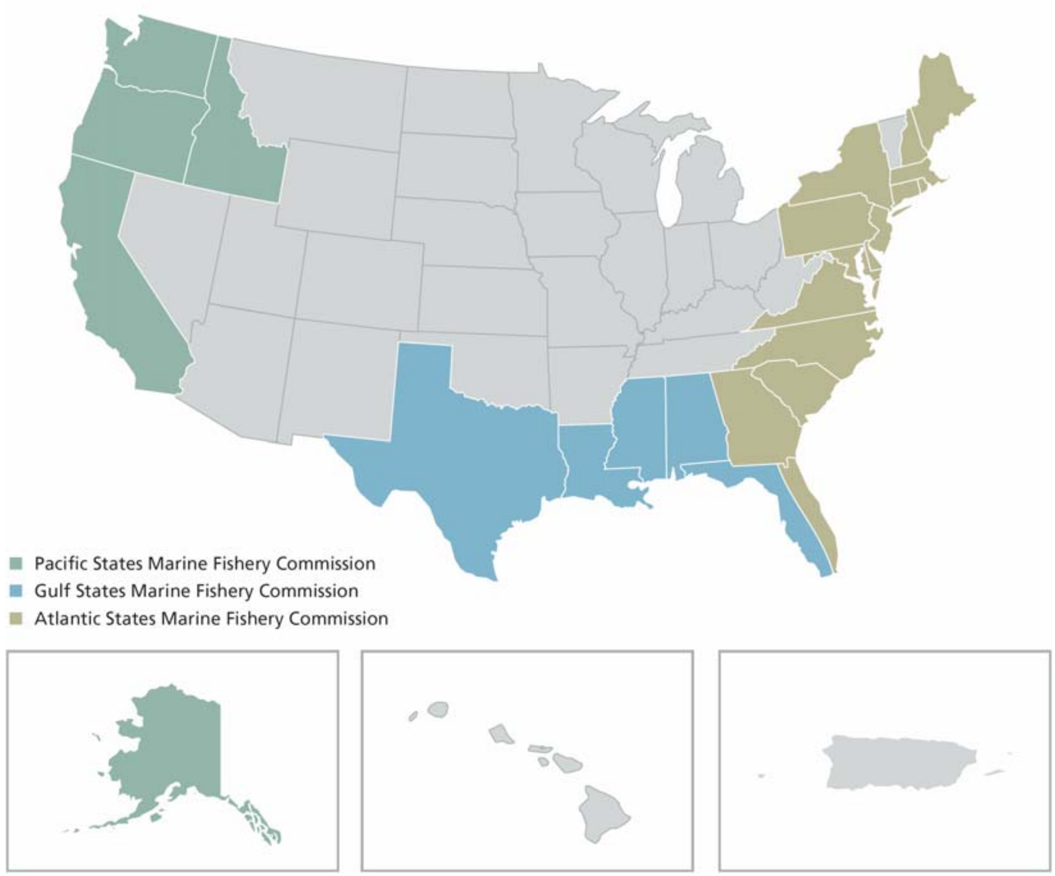
Figure 19.2. Fisheries are Managed at the Regional Level



The Magnuson-Stevens Fishery Conservation and Management Act of 1976 created eight regional fishery councils to manage the harvest of living marine resources within each region. The councils are responsible for sustainable development of domestic fisheries and link the fishing community more directly to the management process. Several states belong to more than one council. For example, Oregon and Washington are members of both the Pacific Council and North Pacific Council.

Each coastal state has authority over fisheries that occur only in that state's waters, while interstate fisheries commissions can develop management plans for fisheries that occur primarily in state waters but cross the boundaries of many states (Figure 19.3).

Figure 19.3. Migratory Fish Require Larger Management Areas



The three interstate marine fisheries commissions are critical to managing and conserving migratory fish that traverse the jurisdictional waters of multiple states.

Interstate Fisheries Commissions

For most of their history, the Atlantic States and Gulf States Marine Fisheries Commissions provided forums for assembling interstate catch statistics and designing fishery management plans to conserve and sustain fish stocks. State compliance with these plans was voluntary. The Gulf States Commission's plans remain voluntary, but the Atlantic Coastal Fisheries Cooperative Management Act of 1994 authorized the Secretary of Commerce to close fisheries that the Atlantic States Commission determined are out of compliance with its management plan. The Pacific States Marine Fisheries Commission is primarily a research coordination agency that provides a forum for discussing interstate fishery issues.

The Great Lakes Fishery Commission, established by agreement between Canada and the United States in 1955, develops coordinated research programs and recommends measures to maximize productivity of Great Lakes fisheries. It also oversees a program to eradicate or minimize sea lamprey populations in the Great Lakes.

Recommendation 19–10. Congress should develop new statutory authority, similar to the Atlantic Coastal Fisheries Cooperative Management Act, to support and empower the Gulf States and Pacific States Fisheries Management Commissions. All interstate management plans should adhere to the national standards in the Magnuson–Stevens Fishery Conservation and Management Act and the

federal guidelines implementing these standards. States should participate in guideline development to ensure they are relevant to interstate plans.

Clarifying Lead Authorities for Joint Planning Purposes

Dividing the natural world into neat management units is never easy, and fish populations are no exception. Although a few fish species remain in one area for most of their lives, others are highly mobile and cross federal, state, and interstate boundaries. The lack of effective mechanisms for coordination and cooperation among the many fishery management entities exacerbates the problem of managing transboundary stocks.

The existing jurisdictional structure requires the development of joint plans, primarily in the Atlantic, by two or more RFMCs, and by the states and RFMCs. In most cases, each entity in the joint planning process has equivalent authority. This joint planning process has generally been inefficient. Joint plans take longer to approve and amend, causing delays in needed conservation measures. In addition, the varied jurisdictions create confusion for fishermen and the public about who is in charge of management and enforcement. Changes are needed to reduce the jurisdictional confusion in marine fishery management and improve cooperation among the states, interstate commissions, RFMCs, and the federal government.

Recommendation 19–11. When a fish stock crosses administrative boundaries, Congress should clearly assign fishery management jurisdiction and authority. For each fishery management plan, a state, Regional Fishery Management Council (RFMC), interstate fisheries commission, or the National Oceanic and Atmospheric Administration (NOAA) should be established as the lead authority. That designation should be based primarily on the proportion of catch associated with each management authority. However, once designated, management authority should not shift based on annual changes in landings.

Specifically, fishery management jurisdiction and authority should be addressed as follows:

- *for interjurisdictional fisheries that occur primarily within state waters, interstate fisheries commissions should take the management lead within both state waters and the exclusive economic zone. For the Atlantic Coast, this could be implemented using authorities provided in the Atlantic Coastal Fisheries Cooperative Management Act. The Great Lakes Fishery Commission should continue to oversee Great Lakes fisheries.*
- *for fisheries that occur primarily in the exclusive economic zone, one RFMC should be responsible for developing the plan. For fisheries that are shared substantially among the jurisdictions of two or more RFMCs, the RFMCs should designate a lead. If the RFMCs are unable to agree, the NOAA Administrator should designate the lead RFMC.*
- *no changes are recommended in jurisdiction for management of highly migratory species.*
- *for any other disputes regarding jurisdiction, the NOAA Administrator should designate the lead authority.*

Improving the Regional Fishery Management Councils

Building on Success

Much of the criticism of fishery management has been directed at the RFMCs. Every council except the North Pacific and Western Pacific has jurisdiction over stocks that are being overfished, and all oversee stocks that have been overfished in the past. The North Pacific RFMC appears to be working well in most facets of its management responsibility. Of the 82 stocks under its jurisdiction with sufficient information to assess, none was classified as overfished in 2001 and only 2 stocks are at levels of abundance that indicate past overfishing. For the remaining seven RFMCs, of the 147 stocks with sufficient information to assess, 33 (22 percent) were being overfished in 2001, and 50 are at levels of abundance that indicate past overfishing. [11]

Despite this mixed record, several aspects of the existing RFMC system echo the major themes outlined in this report: a regional approach to management based on geographically defined ecosystems; a management process that requires local participation; and the incorporation of science-based, peer-reviewed information in the development of management plans. The following recommendations seek to strengthen the management process for all RFMCs, while maintaining the positive features of the system and building on the successes some have achieved.

Broadening Council Membership

The Magnuson–Stevens Act states that the Secretary of Commerce must "to the extent practicable, ensure a fair and balanced apportionment … of the active participants" on the RFMCs. However, the Secretary can only choose RFMC members from the slate of candidates forwarded by the governors. The governors themselves are under no legal obligation to put forth a fair and balanced slate of candidates. Under the Act, their only obligation is to ensure that each candidate is "knowledgeable regarding the conservation and management, or the commercial or recreational harvest, of the fishery resources of the geographical area concerned." This loophole has resulted in uneven representation on some RFMCs.

The governors are not required to recommend candidates from outside the fish harvesting industry, such as consumer groups, academia, subsistence fishermen, or environmental organizations, although these perspectives could help achieve a more balanced management regime. As it stands, the fishing industry representatives who make up the majority of RFMC members may tend to favor economic interests over the long-term sustainability of the stocks. The relatively narrow representation on RFMCs may also fuel legal challenges to fishery management plans based on allegations of conflict of interest—although it should be noted that industry groups challenge fishery management decisions as frequently as public interest groups.

Amendments are needed to ensure that RFMC membership is balanced among competing user groups and other interested parties, and that fishery management plans reflect a broad, long-term view of the public's interests. Identifying the best mix will require knowledge of the federal fishery management process and an understanding of other factors affecting ocean ecosystems. This expertise resides in the NOAA Administrator, not the Secretary of Commerce who is currently responsible for appointing RFMC members.

Recommendation 19–12. Congress should amend the Magnuson–Stevens Fishery Conservation and Management Act to require governors to submit a broad slate of candidates for each vacancy of an appointed Regional Fishery Management Council seat. The slate should include at least two representatives each from the commercial fishing industry, the recreational fishing sector, and the general public.

Recommendation 19–13. Congress should give the Administrator of the National Oceanic and Atmospheric Administration responsibility for appointing Regional Fishery Management Council members with the goal of creating councils that are knowledgeable, fair, and reflect a broad range of interests.

Training New Council Members

Fishery management demands expertise in biology, economics, public policy, and other disciplines. Although RFMC members are required to be knowledgeable about the fishery resources in their region, very few come into the process with resource management experience or scientific training. As Julie Morris, a member of the Gulf of Mexico council, said in testimony before the Commission (Appendix 2), "When I first began working with marine fisheries, the concept of 'spawning potential ratios' was difficult to understand. Now, after six months, I'm still struggling to understand the concepts of optimum yield, biomass at maximum sustainable yield, minimum stock size threshold, and how they all fit together to determine the allowable catch."

NMFS offers a training course for new RFMC members, but they are not required to attend—and many do not. Friction between NMFS and some RFMC members has added to skepticism about the value of this training. As a result, council members often make important decisions affecting fishermen, fishing communities, and fishery resources without an adequate understanding of all relevant scientific, economic, social, and legal information.

Recommendation 19–14. The National Marine Fisheries Service (NMFS) should require all newly appointed Regional Fishery Management Council (RFMC) members to complete a training course within six months of their appointment. NMFS should contract with an external organization to develop and implement this training course and Congress should provide adequate funding. Members who have not completed the training may participate in RFMC meetings, but may not vote.

The training course should:

- *cover a variety of topics including: fishery science and basic stock assessment; social science and fishery economics; the legal requirements of the Magnuson–Stevens Fishery Conservation and Management Act, the National Environmental Policy Act, the Administrative Procedures Act, and other relevant laws or regulations; conflict of interest policies for RFMC members; and the public process involved in developing fishery management plans.*
- *be open to current RFMC members and other participants in the process as space permits.*

ENDING THE RACE FOR FISH

U.S. fishery management has historically made use of access systems—whether open or limited—that promote an unsustainable "race for the fish." This approach has produced serious resource conservation problems in many U.S. fisheries and must be changed.

Traditional Management Approaches

Until the end of the 20th century, most U.S. fisheries allowed access to anyone who wanted to fish. There were few, if any, limits other than the usually nominal cost of a permit and possession of the necessary fishing gear. In profitable fisheries, this led to ever-increasing numbers of entrants, with ever-increasing pressure being put on the fishery resource.

Recognizing the dangers posed by overfishing, managers began to regulate fishermen by placing controls either on input or output. Input controls include such measures as closing access to fisheries by limiting permits, specifying the allowable types and amounts of gear and methods, and limiting available fishing areas or seasons. Output controls include setting total allowable catch (the amount of fish that may be taken by the entire fleet per fishing season), bycatch limits (numbers of non-targeted species captured), and trip or bag limits for individual fishermen.

These management techniques create incentives for fishermen to develop better gear or to devise new methods that allow them to catch more fish, and to do so faster than other fishermen, before any overall limit is reached. They provide no incentive for individual fishermen to conserve fish, because any fish not caught is likely to be scooped up by someone else. This race for fish created an unfortunate cat-and-mouse chase.

In response to each new measure designed to limit fishing effort, fishermen developed new fishing methods that, although legal, undermined the goal of reaching sustainable harvest levels. This prompted managers to promulgate more restrictive measures and fishermen to develop more ingenious methods to work around them. For example, if managers limited the length of the boat, fishermen increased its width to hold more catch. If managers then limited the width, fishermen installed bigger motors to allow them to get back and forth from fishing grounds faster. If managers limited engine horsepower, fishermen used secondary boats to offload their catch while they kept on fishing.

One input control many managers turned to was limiting fishing days for each fisherman or for an entire fleet. In response, many fishermen found ways to increase their fishing effort during the shorter season. In New England, the multispecies groundfish fishery shrank from a year-round fishery to less than a hundred days at sea per fisherman, with recent proposals for even lower limits. In the historically year-round halibut/sablefish fishery in the Gulf of Alaska, the fishing season dwindled to less than a week by the early 1990s.

In addition to conservation concerns, the race for fish can create safety problems. Faced by a sharply curtailed amount of time in which to harvest, fishermen often feel compelled to operate in unsafe weather conditions while loading their boats to capacity and beyond.

The constant race for fish, and the increasingly adversarial relationship between fishermen and managers, created intense pressures. Fishermen fished harder for smaller returns and managers hesitated to further reduce catch limits, fearing political and economic consequences. These pressures have been identified by many as a contributing factor in the decline of several fish stocks, notably the New England groundfish fishery.[12]

For reasons of tradition or culture, most managers hesitated to limit the number of new entrants to a fishery. However, the ineffectiveness of other controls eventually did lead managers in some fisheries to control access, for example by limiting the number of available permits.

Dedicated Access Privileges

To solve the problems described above, managers began exploring dedicated access privileges, a novel form of output control whereby an individual fisherman, community, or other entity is granted the privilege to catch a specified portion of the total allowable catch. With this assurance in place, there would no longer be an incentive for fishermen to fish harder and faster because each could only catch his or her share of the total. The incentive would then be to catch the full share at a low cost and sell the best quality fish at the highest obtainable price.

There are several different types of dedicated access privileges:

- *Individual fishing quotas* (IFQs) allow each eligible fisherman to catch a specified portion of the total allowable catch. When the assigned portions can be sold or transferred to other fishermen, they are called individual transferable quotas (ITQs).
- *Community quotas* grant a specified portion of the allowable catch to a community. The community then decides how to allocate the catch. For example, the Community Development Quota Program in Alaska granted remote villages a portion of the total allowable catch to enhance fishery-based economic development.
- *Cooperatives* split the available quota among various fishing and processing entities within a fishery via contractual agreements.
- *Geographically based programs* give an individual or group dedicated access to the fish within a specific area of the ocean.

Many other variations and combinations of dedicated access privileges are possible. Dedicated access programs can provide substantial benefits in addition to ending the race for fish. Consumers benefit because fresh, rather than frozen, fish are available for most of the year. Many believe that these programs will enhance safety because fishermen will no longer have to go out in bad weather and the U.S. Coast Guard will not be overwhelmed by thousands of fishermen operating in small areas or during a compressed season. Fishermen can develop better long-range business plans because they can more accurately anticipate their annual catch and are less likely to over-invest in boats and gear. They can also fish more carefully, minimizing gear loss and bycatch of protected and other non-targeted species. Finally, these programs allow fishermen and managers to work cooperatively instead of in conflict.

Dedicated Access Privileges: A Better Description

In this chapter, the Commission recommends steps to end the race for fish through the use of "dedicated access privileges." While this term is not new, it is not yet in wide use. More commonly used are the terms "rights-based management," "individual transferable quotas" (ITQs) or "individual fishing quotas" (IFQs). None is satisfactory as a general term.

"Rights-based management" implies granting to an individual the "right" to fish. However, U.S. fishermen do not now and will never have inalienable rights to fish because the fisheries resources of the United States belong to all people of the United States. Under current law, fishermen are granted a privilege to fish, subject to certain conditions. Because this privilege can be taken away, it is not a right.

The second two terms, ITQs and IFQs, are too narrow for general application. Both terms describe specific kinds of dedicated access privileges. Their general use has caused confusion, creating the impression that ITQs or IFQs are the only tools that can end the race for fish. In many areas, particularly along the east coast, the term ITQ has gained a negative connotation as the result of events in the surf clam/ocean quahog ITQ program. In addition, both terms imply that individual fishermen own a share of a public resource.

The term dedicated access privileges is preferable for several reasons. First, it highlights the fact that fishing is a privilege, not a right. Second, it is an umbrella term that includes access privileges assigned to individuals (ITQs; IFQs; individual gear quotas), as well as to groups or communities (community development quotas; cooperatives; area-based quotas, community-based quotas). Finally, it reflects the fact that the dedicated privilege being granted is *access* to the fish, rather than the fish themselves.

Currently, four U.S. fisheries grant dedicated access privileges: the surf clam/ocean quahog fishery in the Mid-Atlantic (ITQ); the wreckfish fishery in the South Atlantic (ITQ); the halibut/sablefish fishery in the North Pacific (ITQ); and the Bering Sea pollock fishery in the North Pacific (co-op). Many other countries, including New Zealand, Australia, and Iceland, rely heavily on dedicated access regimes for fishery management.

But dedicated access regimes are not without their drawbacks. After the ITQ program began in the Mid-Atlantic surf clam/ocean quahog fishery, fleet size shrank from 128 vessels to 59 vessels in two years because many fishermen decided to simply sell their share of the harvest to outside investors. By 1995, very few owner-operators were left in the fishery, and the largest holders of fishing quotas were a bank and an accounting firm. To many observers, this turned the working fishermen into the equivalent of sharecroppers for absentee landlords.[13]

Based largely on that experience, many fishermen, especially in New England, opposed any effort to explore ITQs. Some RFMC members also questioned the enforceability of dedicated access privileges in multispecies fisheries with large numbers of participants or many ports of landing. Public interest groups also expressed concerns, although for very different reasons. They felt that granting fishermen exclusive access to harvest, buy, or sell a portion of the overall catch appeared to create an individual property right to a public resource, although all existing dedicated access programs in the U.S. clearly state that granting an individual access to a portion of the catch does not confer a right to any fish before it is harvested.

In response to such concerns, the 1996 amendments to the Magnuson–Stevens Act created a moratorium on further development of IFQ programs, pending consideration by the National Academy of Sciences. The resulting National Research Council study concluded that IFQ programs are in fact a promising management option that RFMCs should consider.[14] Examples of carefully designed dedicated access programs in the United States and elsewhere show that it is possible to overcome most of the concerns raised about them. During the development of the Alaska halibut/sablefish dedicated access program, concerns were raised about the socioeconomic impacts of individual fishing quotas on communities. As a result, the North Pacific RFMC customized the program to account for vessel size and type, placed a one percent cap on the share of quota any one person or entity could control, and prohibited absentee ownership to ensure quotas would remain in the hands of working fishermen. Halibut and sablefish fishermen, previously skeptical, are now among the program's biggest supporters. This illustrates the value of taking potential socioeconomic ramifications and other stakeholder concerns into account during the design phase of any dedicated access program.

Even though the Magnuson–Stevens Act moratorium on individual fishing quotas has expired and the National Research Council study endorsed this as a viable approach, most RFMCs will remain unwilling to spend time and effort developing dedicated access programs until they are sure Congress will not overrule them.

Recommendation 19–15. Congress should amend the Magnuson–Stevens Fishery Conservation and Management Act to affirm that fishery managers are authorized to institute dedicated access privileges. Congress should direct the National Marine Fisheries Service to issue national guidelines for dedicated access privileges that allow for regional flexibility in implementation. Every federal, interstate, and state fishery management entity should consider the potential benefits of adopting such programs.

At a minimum, the national guidelines should require dedicated access programs to:

- *specify the biological, social, and economic goals of the plan; recipient groups designated for the initial quota shares; and data collection protocols.*
- *provide for periodic reviews of the plan to determine progress in meeting goals.*
- *assign quota shares for a limited period of time to reduce confusion concerning public ownership of living marine resources, allow managers flexibility to manage fisheries adaptively, and provide stability to fishermen for investment decisions.*
- *mandate fees for exclusive access based on a percentage of quota shares held. These user fees should be used to support ecosystem-based management. Fee waivers, reductions or phase-in schedules should be allowed until a fishery is declared recovered or fishermen's profits increase.*
- *include measures, such as community-based quota shares or quota share ownership caps, to lessen the potential harm to fishing communities during the transition to dedicated access privileges.*
- *hold a referendum among all permitted commercial fishermen after adequate public discussion and close consultation with all affected stakeholders, to ensure acceptance of a dedicated access plan prior to final* Regional Fishery Management Council *approval.*

Reducing Overcapitalization of Fishing Fleets

As discussed above, the race for fish pushes fishermen to invest more and more capital to buy bigger, faster boats, new gear and additional labor. These investments are perceived as essential to stay alive in the race for fewer and fewer fish, not necessarily to make the business more efficient. The inevitable result is economic decline, with more vessels pursuing a shrinking resource. If managers respond by further lowering the total allowable catch, costs rise even more while average revenues drop.

Over the past three decades, federal programs to subsidize the purchase or upgrade of fishing vessels have resulted in U.S. fishing capacity that far exceeds the available catch. For example, the Capital Construction Fund allowed fishermen to create tax-free accounts to repair or construct vessels, and the Fishing Vessel Obligation Guarantee Program provided long-term credit for fishing vessels and related facilities. The challenge now goes beyond removing subsidies and incentives that promote overcapitalization; it will also take a sustained effort to reduce the excess capacity already in place.

Past capacity reduction efforts, such as the New England groundfish buyout program in the early 1990s, have been effective at removing capacity from the fleet. However, their initial success was undermined when new fishermen and boats were allowed to replace those that had been retired. A new federal program, the Fishing Capacity Reduction Program, has been criticized as being too bureaucratic and slow.

Two types of management regimes can ensure that a capacity reduction program has lasting results: (1) dedicated access programs which, by definition, limit overall effort in a fishery; and (2) restrictive regimes that freeze the number of active fishermen and prohibit any changes to fishing methods or gear until a fishery has been declared recovered. The second option would be difficult to enforce and could meet with strong resistance from fishermen and managers. Yet steps must be taken to end the inefficient and counter-productive over-investment in fishing vessels and gear.

Recommendation 19–16. Congress should repeal the Fisheries Finance Program (formerly the Fishing Vessel Obligation Guarantee Program), the Capital Construction Fund, and other programs that encourage overcapitalization in fisheries. The National Oceanic and Atmospheric Administration (NOAA) should implement programs to permanently reduce fishing capacity to sustainable levels.

Reducing overcapitalization in fisheries will be assisted by the following:

- *to the maximum extent practicable, capacity reduction programs should be funded by those who profit from them—the fishermen remaining in the fishery.*
- *federal contributions to capacity reduction programs should only be made where additional effort is prohibited from entering the fishery. The highest priority for public funding of capacity reduction should be given to fisheries that grant dedicated access privileges to participants.*
- *NOAA should monitor capacity reduction programs to ensure they meet their objectives.*
- *fishermen should be allowed to transfer existing Capital Construction Fund accounts into IRAs or other appropriate financial instruments.*

Improving Fishery Enforcement

Enforcement of fishing restrictions is essential to allow fishery resources to be economically harvested and protected for future generations. However, increasing pressures on agencies hinder effective enforcement and delay the evolution of fishery management plans toward a more ecosystem-based approach. For example, area closures put greater demands on enforcement agencies that must patrol larger, more widely dispersed areas. Redirection of existing enforcement resources for homeland security and the reduction of state personnel due to budget cuts also hamper fisheries enforcement. If this gap between needs and resources is to be narrowed, the agencies tasked with enforcing fishery management plans must apply resources and technology in innovative ways, such as through enhanced vessel monitoring technologies, expanded cooperation between enforcement agencies, and strengthened public education and outreach.

Fishery Enforcement Mechanisms

The two federal agencies with primary roles in enforcing marine fishery regulations are NMFS and the Coast Guard. Under the authority of the Magnuson–Stevens Act, these agencies enforce conservation and management plans for federally regulated fishery resources in the 200 nautical mile EEZ. The Coast Guard also enforces applicable international agreements in waters beyond the U.S. EEZ.

The Coast Guard employs personnel, vessels, aircraft, communications and support systems to maintain a law enforcement presence in the EEZ and on the high seas. Agents from NMFS' Office of Law Enforcement conduct dockside inspections, investigate civil and criminal violations, seize illegal property and contraband, and seek to prevent unlawful trafficking in marine wildlife products. State enforcement personnel enforce state fishery plans in their own waters and federal plans if there is a cooperative agreement.

Both the Coast Guard and NMFS enforcement representatives participate in the RFMC process. The Coast Guard and NMFS also cooperate with state enforcement agencies to pool limited assets and reduce duplication of effort.

Enforcement Partnerships

New partnerships and enhanced cooperation are basic elements of the Coast Guard and NMFS fishery enforcement strategic plans. Cooperative enforcement agreements among federal, state, tribal, interstate, and international organizations will be essential as ecosystem-based or area-based management becomes more prevalent and as the Coast Guard assumes additional homeland security responsibilities.

Cooperative Enforcement Programs

One of the most successful existing partnership programs is the Cooperative Enforcement Program between NMFS and state agencies. In this program, state enforcement officers are deputized to enforce state and federal fishery management plans for commercial and recreational fisheries. Through Joint Enforcement Agreements (JEAs), NMFS provides federal funds for state involvement which are then matched by the states, providing an opportunity to enlarge the overall pool of enforcement resources. JEAs have also led to significant progress in creating uniform enforcement databases, identifying regional and local fishery enforcement priorities, and extending coordination to other areas, such as investigations.

Twenty-three coastal states and territories have entered into JEA partnerships with NMFS. From 1998 to 2000, following implementation of the JEA with South Carolina, state patrol officers logged over 1,095 hours conducting federal enforcement from the edge of state waters to 70 nautical miles offshore. Their patrols uncovered 172 cases of fisheries violations in the EEZ or on vessels returning from the EEZ, as well as many additional cases of boating safety and permit violations.[15] JEAs are particularly effective because state agents are familiar with local waters, know when and where enforcement infractions are likely to occur, and provide opportunities for significant public outreach and education.

Although the Coast Guard is not currently a signatory to these cooperative NMFS–state agreements, Coast Guard participation would be valuable, particularly during the development of enforcement plans and priorities, and would help assure commitment of Coast Guard resources to joint enforcement efforts.

Despite the JEA program's advantages in leveraging resources and enhancing cooperation, its federal funding was reduced from approximately $15 million in fiscal year 2001 to $7 million in the fiscal year 2002 and 2003 budgets. The reduced federal funding led to smaller state matching appropriations and, ultimately, a reduction in enforcement personnel.

Recommendation 19–17. Congress should increase funding for Joint Enforcement Agreements to implement cooperative fisheries enforcement programs between the National Marine Fisheries Service and state marine enforcement agencies. The U.S. Coast Guard should be included as an important participant in such agreements.

Cooperative Federal Enforcement

There are also significant opportunities to strengthen cooperation at the federal level between NMFS and the Coast Guard. Currently, each agency has its own strategic plan, goals and objectives for enforcement of federal fisheries laws. At the regional and local levels, the degree of cooperation is uneven and can vary considerably over time, even within the same geographic area.

At the national level, a jointly developed strategic plan for federal fisheries enforcement can provide a framework for prioritizing common goals and identifying cooperative enforcement policies. At the regional level, existing agency training centers can be given a broader role as forums for NMFS, Coast Guard, and state enforcement personnel to share information specific to a particular fishery, and to identify opportunities for more effective resource utilization. At the regional and local levels, a stronger and more consistent process can be developed for joint planning and implementation of fishery enforcement operations. Strengthening the national, regional, and local frameworks should lead to better resource utilization and fisheries enforcement.

Recommendation 19–18. The National Marine Fisheries Service and the U.S. Coast Guard should strengthen cooperative enforcement efforts at the national level by developing a unified strategic plan for fisheries enforcement that includes significantly increased joint training, and at the regional and local levels, by developing a stronger and more consistent process for sharing information and coordinating enforcement.

Technology for Enforcement

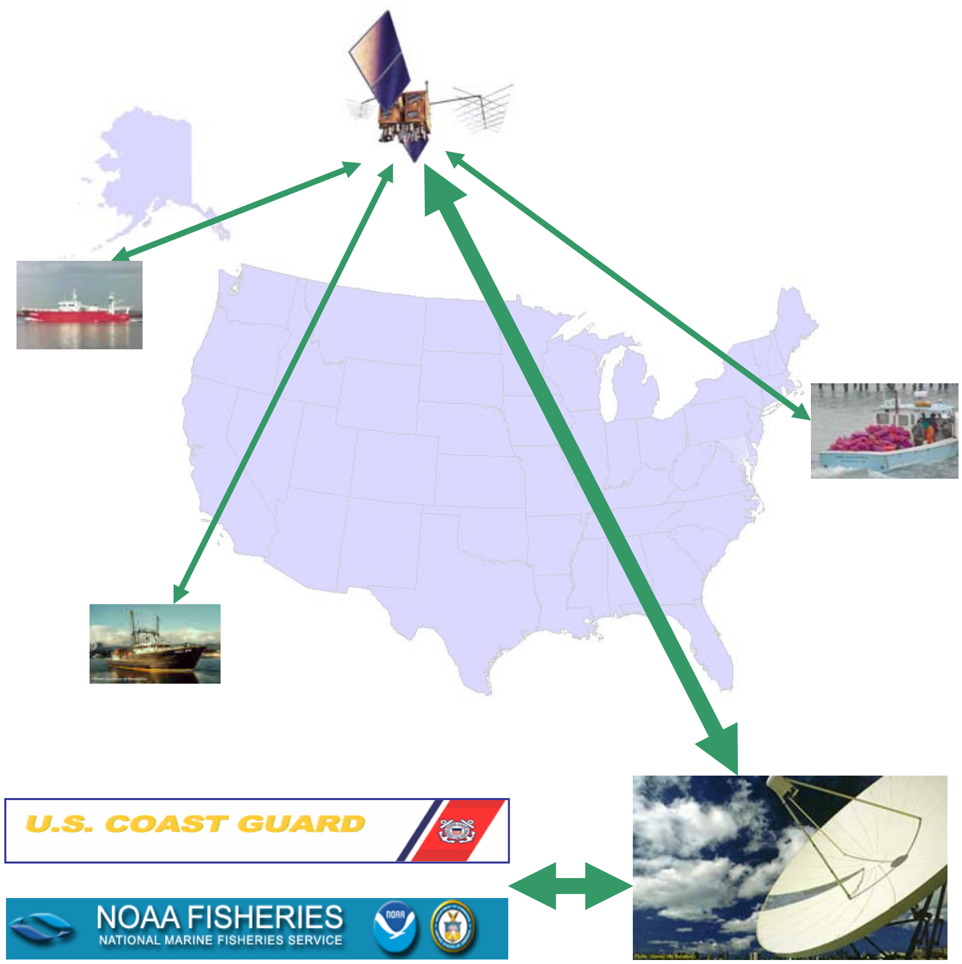
Vessel Monitoring System

Vessel monitoring is now an accepted part of fishery management worldwide and is endorsed by the United Nations Food and Agriculture Organization's Code of Conduct for Responsible Fisheries. Since its initial implementation in 1988, the Vessel Monitoring System (VMS) has dramatically increased the effectiveness of limited fishery enforcement resources.

Ships equipped with VMS transmit accurate Global Positioning System data via satellite to monitoring centers ashore (Figure 19.4). This information identifies specific vessels and their precise locations. When fully implemented, the system can also provide information useful to law enforcement, maritime security, safety efforts, environmental protection, and resource management.

VMS can be configured for two-way communications to enable vessels to receive pertinent safety and enforcement information from observing parties onshore, such as weather alerts and safety broadcasts for vessels in potentially hazardous circumstances. In emergencies, the Coast Guard can pinpoint the location of a stricken vessel and communicate directly with it and other boats in the area through two-way VMS links. Two-way VMS allows fishermen to be in constant contact with other fishermen, enforcement personnel, and fleet operators. Because their position can be verified, fishermen can remain on scene longer prior to fishery closures, rather than having to depart the area as is often currently required. The extension of VMS monitoring to state fisheries could also be useful, particularly for vessels wanting to operate legally in state waters adjacent to closed federal waters.

Figure 19.4. Monitoring Fisheries from Space



The Vessel Monitoring System (VMS) transmits Global Positioning System data from vessels to enforcement monitoring stations via satellite. VMS can also be configured for two-way transmission, allowing VMS personnel to send useful information to fishermen at sea.

Beyond the benefits to fishermen and the potential benefits to scientific research through the transmission of near real-time data, two-way VMS is a useful system for enforcement and management personnel. Enforcement personnel can protect resources by preventing potential fishery violations, and VMS can save the Coast Guard and NMFS time and money spent in enforcement actions. The system provides the Coast Guard and NMFS a broader awareness of ships as they approach restricted areas, enabling the agencies to inform a fishing vessel that it is about to enter a protected area. Sensors can also be added to fishing gear, allowing VMS to indicate when a vessel is actively fishing. Managers can also use VMS system capabilities for daily catch and effort information used in quota management, and can gather other data, such as temperature, depth, and salinity, to inform broader fishery management planning decisions.

The cost of VMS for fishing vessel owners is small relative to its many benefits. VMS equipment with two-way communications capabilities is available at a modest cost of several thousand dollars. Some current NMFS programs offer limited reimbursement for initial equipment purchase. In addition to the one-time installation costs, there are continuing, although modest, costs associated with data transmission.

Recommendation 19–19. The National Marine Fisheries Service, working with the Regional Fishery Management Councils, the U.S. Coast Guard, and other appropriate entities, should maximize the use of the Vessel Monitoring System (VMS) for fishery-related activities by requiring that VMS with two-way communication capability be phased in for all commercial fishing vessels receiving permits under federal fishery plans, including party and charter boats that carry recreational fishermen, incorporating VMS features that assist personnel in monitoring and responding to potential violations, and identifying state fisheries that could significantly benefit from VMS implementation.

Integrating VMS into a Data Collection and Dissemination System

Although NMFS is currently overseeing the development of the VMS fisheries enforcement infrastructure nationwide, VMS data are also being incorporated into a larger monitoring system that extends beyond fishery enforcement concerns. VMS data will be part of a multipurpose data collection and dissemination system that includes other Coast Guard data sources and provides a comprehensive picture of many offshore activities. The larger Coast Guard data system will support a variety of missions, such as maritime security, safety, search and rescue, law enforcement, and environmental protection (Chapter 16). The Coast Guard and NMFS will need to cooperate to establish uniform national policies and technical requirements for VMS information, while providing for regional flexibility.

Recommendation 19–20. The U.S. Coast Guard should be the lead organization in managing the integration of a fishery Vessel Monitoring System (VMS) database into the larger maritime operations database and should work with the National Marine Fisheries Service to ensure effective use of VMS data for monitoring and enforcement.

Using New Technologies for More Effective Enforcement

VMS presents just one of many opportunities to use technology for more effective enforcement. Fixed radars on platforms have been used successfully in particularly sensitive environmental areas close to shore, and satellites present additional opportunities for offshore monitoring. The advantage of these monitoring systems is that they identify vessel traffic and activity in a particular area so that enforcement resources can be sent to investigate only when circumstances warrant. Directed enforcement efforts are less costly than general enforcement patrols. Enforcement planning at all levels should include a continuing focus on identifying and funding new and emerging technologies that provide for more successful and cost-effective use of enforcement resources.

Improving Enforceability as Part of the Management Process

Clear, easily enforceable regulations are critical to the success of fishery management policies. A management regime that is—or is perceived by the public to be—impossible or exceptionally hard to enforce is unlikely to succeed. Of course, some management regimes are more difficult or costly to enforce than others. In particular, area closures with boundaries that are difficult to detect at sea are problematic and provide tenuous grounds for legal action. Enforcement difficulties are also generated by gear restrictions that require fishermen to haul out their gear for boarding officers to examine. As part of their effort to ensure sustainable fisheries, the RFMCs should pay particular attention to enforceability when drafting management plans.

Moving Toward an Ecosystem-Based Management Approach

In keeping with the overarching theme of this report, fishery managers should begin to move toward a more ecosystem-based management approach. This will provide direct benefits to the ecosystem and create a better mechanism for addressing apparent conflicts between socioeconomic and biological goals.

Linking Fisheries Management with other Regional Concerns

Several measures now in place have begun the transition to a more ecosystem-based approach to fishery management. Such an approach requires that we look beyond fisheries to consider interactions with other resources and activities.

The fishery regions were originally defined roughly along the lines of Large Marine Ecosystems and thus have the geographic reach necessary to encompass ecosystem concerns. In addition, all RFMCs have multispecies management plans that force the councils to look broadly at the ecosystem they manage. Despite these positive efforts, most RFMC multispecies fishery management plans now focus only on species assemblages that are commercially important, or those taken by particular types of gear. Little attention is given to species that, while commercially insignificant, are still important to the functioning of an ecosystem. New ecosystem-based measures are needed, such as studies of system components and interrelationships, assessment and ranking of dangers, and development of comprehensive management plans. These should carefully consider the relationship between fishery management measures and management of other sectors, including protected species, pollution control, and habitat conservation and restoration.

Fishery managers have also used marine protected areas to either promote stock recovery or, in some circumstances, prevent damage to special habitats. In addition, marine protected areas established for other purposes have benefited many fisheries. The initial steps in designing marine protected areas need to be improved. (For further discussion of marine protected areas, see Chapter 6.)

In some respects, the job of the RFMCs will change little with the move toward ecosystem-based management. The councils will retain broad responsibilities for managing fish populations and fishing activities, bearing in mind the interests of fishing communities. However, they will also need to interact regularly with other regional, state, and local entities with related responsibilities. For example, if an RFMC implements a scientifically sound fishery management plan, but the stock continues to decline due to other factors such as pollution, the problem could be raised at the regional level (as described in Chapter 5) with managers responsible for pollution control. On the other hand, if coastal managers develop a regulatory plan that could affect fisheries, they should be working with the RFMCs to understand the fishery-specific implications. There also should be changes in the way that management measures are evaluated to comply with NEPA. As regions implement an ecosystem-based management approach, environmental impact assessments should be based on a shared knowledge of the ecosystem across the planning entities. Rather than having the RFMC, NMFS, EPA, and the U.S. Army Corps of Engineers all prepare separate environmental impact statements, without sharing information on cumulative impacts, these analyses need to be combined to reduce duplication and improve the quality of ecosystem evaluations.

Ecosystem-based management will also bring changes to the RFMC process. As mentioned elsewhere in this chapter, fishery management plans have traditionally focused on single stocks, or at most, groupings of stocks that are commercially important. Managers usually set biomass or mortality rate goals, with little consideration of other characteristics of the stock, and even less of broader ecosystem concerns. With the move toward an ecosystem-based management approach, this will change.

Several recent reports have described the profound impacts that fishing industry activities can have on marine ecosystems, such as reducing the average size of individuals within a single stock or removing a high percentage of large predators like tuna and billfish.[16] By targeting some species and not others, fishermen can affect the balance and structure of ecosystems. In the Gulf of Maine, some scientists believe that the multispecies fishery has contributed to a re-structuring of that ecosystem from one dominated by groundfish to one dominated by dogfish and skates. Fishery managers need to take such impacts into account in developing management plans and amendments.

An ecosystem-based management approach will also allow managers to better consider the impacts of their plans on fishermen and the communities in which they live. Unfortunately, the amount of sociologic or economic information we have on fishermen and fishing communities is paltry. It is important to collect such data so managers can better understand the overall effects of the measures they take and the plans they approve. The more managers know about the social and economic factors influencing fishing behavior, the more success they will have in designing regulations that have the intended effect.

The 1996 amendments to the Magnuson-Stevens Act specifically recognize the need to consider the impact of fisheries management measures on fishing communities. Although NMFS has begun to improve its ability to describe and predict such impacts, further improvements in collecting and interpreting socioeconomic data are needed. To this end, the legal barriers that now exist to collecting some economic information from fishermen and processors should be reconsidered.

The move toward an ecosystem-based management approach will also allow the human and biological components of fisheries to be brought together through consideration and adoption of ecosystem goals and objectives. As discussed in Chapter 3, goal setting is an important but difficult part of ecosystem-based management. As in any system with multiple competing objectives, it will not be possible to meet every one.

In fisheries, the competition is usually between helping overfished stocks recover and preserving the short-term economic health of traditional fishing communities. Both goals are desirable but the measures required to achieve them often appear to be in conflict. Yet long-term economic health depends on healthy fish stocks. This may require a temporary reduction in fishing effort, with related short-term economic pain. The challenge is to devise a formula that rebuilds stocks at a reasonable rate without causing unacceptable economic hardships.

Scientists can help predict how quickly a stock will be replenished at different harvest levels, but there is no scientific basis for actually deciding what the appropriate rate of rebuilding should be. That is a judgment call, requiring managers to weigh the benefits of quickly restoring fish stocks to healthy and sustainable levels against the interim economic costs to the fishermen and communities involved. The task is complicated by the fact that even short-term hardships can drive fishermen permanently out of business. Ironically, the resultant pressure to go slow has sometimes led to continued overfishing…and even deeper and longer-term socioeconomic harm. An ecosystem-based management regime will inevitably require tough choices, but it does provide a comprehensive context within which those choices may be made.

The RFMCs should participate in a collaborative process to share their concerns and help shape regional goals and management plans. Because of their experience in dealing with diverse constituents and multiple objectives, the councils could be extremely helpful in developing a comprehensive ecosystem-based management approach in the regions.

In addition to integrating fishery issues into an overall regional perspective, the principles of ecosystem-based management can guide NMFS and the RFMCs in implementing two difficult provisions of the Magnuson–Stevens Act related to essential fish habitat and bycatch.

Essential Fish Habitat

As discussed in Chapter 11, maintaining healthy, functioning habitats is an essential element of an ecosystem-based management approach. The 1996 amendments to the Magnuson–Stevens Act included measures designed specifically to protect habitats important to managed species. Essential fish habitat (EFH) is defined in the Act as "those waters necessary to fish for spawning, breeding, or growth to maturity" and the RFMCs are required to "describe and identify essential fish habitat" for each fishery. However, it is not easy to determine which habitats are required by fish. With scant legislative guidance and little scientific information available on habitat requirements, RFMCs tended to be broad in their designations.

For example, in the case of Atlantic halibut, the New England RFMC designated the entire Gulf of Maine and almost all of Georges Bank as essential. The North Pacific council designated almost the entire EEZ below the Arctic Circle as essential for one species or another. But when everything is special, nothing is. The current methods have resulted in the designation of so much habitat that the original purpose of identifying areas that deserve focused attention has been lost.

Perhaps in recognition of this, NMFS designated a subset of EFH to be called "habitat areas of particular concern." These areas were defined in 2002 NMFS regulations as "discrete areas within essential fish habitat that either play especially important ecological roles in the life cycles of federally managed fish species or are especially vulnerable to degradation from fishing or other human activities." Less than one percent of the area initially designated as EFH has been further characterized as habitat areas of particular concern.

Two alternate approaches for determining critical habitat attempt to improve on the current one. Both look at habitat from an ecosystem perspective, instead of trying to identify habitat necessary for the survival of an individual species. The first approach uses the abundance of juveniles of several commercially important species as indicators of habitat preference.[17] It then uses a statistical method to locate the smallest total area that contains a sufficient amount of preferred habitat for all species of concern. The second approach expands on the first, by attempting to link species distribution with specific habitat types.[18]

Of course, the identification of important habitats is only the first step. Rather than focusing solely on protecting these habitats from fisheries impacts, NOAA should identify the full range of threats and work with other agencies to develop management plans that mitigate the activities posing the greatest risks. Ultimately, the process for designating and managing EFH should result in the protection of major fish species during vulnerable stages of their life history, while minimizing disruption to fisheries or other offshore uses. Like other resource management programs, any approach to protecting EFH must also be enforceable and reasonably simple to implement.

Recommendation 19–21. The National Marine Fisheries Service (NMFS) should change the designation of essential fish habitat from a species-by-species to a multispecies approach and, ultimately, to an ecosystem-based approach. The approach should draw upon existing efforts to identify important habitats and locate optimum-sized areas to protect vulnerable life-history stages of commercially important species. NMFS should work with other management entities to protect essential fish habitat when such areas fall outside their jurisdiction.

This effort should include:

- *well-documented, science-based analytical methods.*
- *consideration of ecologically valuable species that are not necessarily commercially important.*
- *an extensive research and development program to refine existing analytical methods and develop additional means to identify habitats critical to sustainability and biodiversity goals.*

Reducing Bycatch

The unintentional catch of non-targeted species by recreational and commercial fishermen, commonly known as "bycatch," is a major economic and ecological problem. One of the national standards of the Magnuson–Stevens Act states that fishery management plans should minimize bycatch to the greatest extent practicable. Reducing bycatch is a goal that everyone can support: for fishermen, bycatch decreases efficiency and costs money; for the environmental community and many others, bycatch is viewed as wasteful and harmful to the ecosystem; and, in the case of endangered species, bycatch can threaten a population's survival. Nevertheless, the total elimination of bycatch from a fishery is probably impossible, and too great a focus on bycatch could inhibit progress on other issues more important to ecosystem functioning.

The first requirement for addressing bycatch is better information. Existing fish stock assessments attempt to account for all sources of mortality for commercially targeted species; however, estimates of impacts on non-target species are lacking. An ecosystem-based management approach will require that mortality to all components of the system be estimated. Of course, cataloging all bycatch in every fishery would only be possible if an observer were placed on every fishing boat, a prohibitively expensive proposition. Instead, bycatch monitoring should be based on statistically significant sampling, using information gathered by fishermen and a selected number of observers.

NMFS, in cooperation with the RFMCs, has initiated a National Bycatch Strategy that moves in the right direction.[19] The strategy calls for the development of regional implementation plans to reduce bycatch, but only of specific commercially important species. As ecosystem-based management evolves, those implementing the National Bycatch Strategy will need to look more broadly at overall ecosystem impacts.

Recommendation 19–22. The National Marine Fisheries Service (NMFS) and Regional Fishery Management Councils should develop regional bycatch reduction plans that address broad ecosystem impacts of bycatch. Implementation of these plans will require NMFS to expand current efforts to collect data on bycatch, not only of commercially important species, but on all species captured by commercial and recreational fishermen. The selective use of observers should remain an important component of these efforts.

Managing International Fisheries

The Status of International Fisheries

Intensive exploitation of fish populations at the international level is jeopardizing global marine life and the marine environment. An estimated seven out of ten fish stocks worldwide are being exploited at or beyond the level of sustainability.[20] Not unlike the U.S. situation, factors contributing to the rapid depletion of global fish stocks include:

- the open-access nature of high seas fisheries;
- excess fishing capacity, with global investments annually exceeding revenues by $14.5 to $54 billion;[21]
- widespread illegal practices, and difficulties in enforcing the law;
- ever more sophisticated fishing technology and gear;
- major government subsidies aimed at building up national fishing industries;
- bycatch of non-target species;
- high levels of discards, reaching approximately 20 percent of the total catch;[22]
- fishing practices that degrade habitat;
- inadequate understanding of how marine ecosystems function; and
- lack of monitoring data and poor statistics.

The Law of the Sea Framework

As noted in Chapter 2, the traditional freedom of the high seas was based on a belief that the ocean's bounty was inexhaustible and that humans would never be in a position to exploit much of it. As ocean resources grew in importance, and its vastness was conquered, these attitudes changed. In 1976, the United States asserted jurisdiction over fishery resources within 200 nautical miles from its shores. In 1982, the United Nations Convention on the Law of the Sea (LOS Convention) created EEZs extending generally out to 200 nautical miles from the shores of all coastal states.

In restricting what had previously been part of the high seas, the LOS Convention initially put more emphasis on national self-interest than on international cooperation in managing fish stocks. But many stocks transcend a single country's EEZ, including highly migratory stocks (like tuna) and those that migrate between fresh water and the open ocean (like salmon and eels). In the absence of international cooperation and some form of international governance, the community of nations could witness the classic "tragedy of the commons," leading to the potentially irreversible overexploitation of living marine resources.

International management challenges are exacerbated by the fact that the regulation of fishing on the high seas has traditionally been left to the nation under which a vessel is registered—the so-called flag state. As discussed in Chapter 16, flag state enforcement is extremely uneven and vessel owners can seek less stringent regulations and enforcement simply by reflagging their vessels.

Global Fishery Conservation Agreements

In the 1990s, the international community, working mainly through the United Nations Food and Agriculture Organization's (FAO's) Committee on Fisheries, began to address deficiencies in international fisheries management, with the United States playing a lead role. Two global agreements were reached that are binding on signatories: the FAO Compliance Agreement and the Fish Stocks Agreement. The FAO also adopted a number of voluntary measures that provide guidance to nations on managing fisheries. Although they do not have the force of law, these nonbinding instruments can influence national practices and customs, provide nations with flexibility in implementation, and make headway in the face of scientific or economic uncertainty.

The FAO Compliance Agreement

In 1993, the FAO adopted the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas*,* known as the FAO Compliance Agreement. This agreement requires each participating flag state to:

- ensure that vessels flying its flag do not undermine international conservation measures;
- limit the right to harvest fish to those vessels it has affirmatively authorized;
- maintain a register of such authorized fishing vessels; and
- monitor catches and make such information available to the FAO.

The United States ratified the FAO Compliance Agreement in 1995, and it came into force in 2003, when a sufficient number of nations had signed. However, many major fishing countries—including Norway, Sweden, Mexico, Japan, Canada, and Argentina,—have still not ratified the Agreement and are, therefore, not bound by its provisions.

The Fish Stocks Agreement

At the 1992 United Nations Conference on Environment and Development (also known as the Earth Summit), the nations of the world recognized that the LOS Convention's appeal for international cooperation on straddling stocks and highly migratory species did not adequately address the global crisis in fisheries. The result was the 1995 United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (known as the Fish Stocks Agreement).

The Fish Stocks Agreement authorizes nonflag states to engage in compliance and enforcement activities for fishery violations on the high seas, including boarding, inspecting, and bringing a vessel to port. It also allows port states to inspect documents, fishing gear, and catch on board fishing vessels and to prohibit landings if a high seas catch has been taken in a manner that undermines regional or global conservation and management measures.

The Fish Stocks Agreement adopts a precautionary approach as the fundamental standard for managing shared fisheries and calls upon nations to agree on efficient and expeditious decision-making procedures within regional organizations. The United States was a leader in negotiating the Fish Stocks Agreement and in 1996 became the third nation to ratify it. The Agreement finally came into force in late 2001, although several major fishing nations, including Japan, Poland, Korea, and Taiwan, have not yet ratified it.

Recommendation 19–23. The U.S. Department of State, working with other appropriate entities, should encourage all countries to ratify the Fish Stocks Agreement and the United Nations Food and Agriculture Organization's Compliance Agreement. In particular, the United States should condition other nations' access to fishing resources within the U.S. exclusive economic zone on their ratification of these agreements. Other incentives should be developed by the United States and other signatory nations to encourage all nations to ratify and enforce these agreements.

The effective management and conservation of global marine species, and the enforcement of international treaties, require a combination of domestic, bilateral, regional, and international approaches. Although regulation of fisheries on the high seas is conducted within broad regions of the seas, the existing regional fishery organizations are generally weak. They lack adequate financial resources or enforcement capabilities, and allow member states to opt out of individual management measures they dislike.

The United States is a member of more than a dozen regional fishery commissions and related organizations concerned with straddling stocks or high seas living marine resources. These organizations undertake fishery research, adopt measures to conserve and manage the fisheries under their mandate, and attempt to reduce and regulate bycatch. They also develop policies for the conservation, sustainable use, and ecosystem-based management of living marine resources.

The work of regional fishery organizations must be paid for by their members. The cost of U.S. participation is set at roughly $20 million annually, although in fiscal year 2003, Congress did not appropriate the amount requested.

Recommendation 19–24. Congress should fully fund existing U.S. commitments to international fisheries management. The U.S. Department of State, working with the National Oceanic and Atmospheric Administration, should review and update regional and bilateral fishery agreements to which the United States is a party, to ensure full incorporation of the latest science and harmonize those agreements with the Fish Stocks Agreement.

Non-binding International Documents

The FAO has adopted a number of voluntary, nonbinding instruments, beginning in 1995 with the Code of Conduct for Responsible Fisheries (the Code). While acknowledging the diversity of national and cultural traditions, the Code sets out principles and standards for responsible practices in fisheries and aquaculture. Its purposes are to promote conservation of biodiversity, ecosystem-based management, and sustainable use of living marine resources. More specifically, the Code calls for use of the best scientific information, application of traditional knowledge where possible, adoption of an ecosystem-based and precautionary approach, effective flag state control, and participation in regional organizations.

More recently, the FAO has adopted a number of International Plans of Action that elaborate on the Code and address weaknesses in existing regulatory schemes involving such issues as the bycatch of seabirds and sharks. The International Plan of Action on illegal, unreported, and unregulated fishing, although emphasizing flag state responsibility, also calls upon regional organizations to play a role in monitoring, surveillance, and deployment of observers, and urges port state control. These International Plans of Action can be best implemented through corresponding National Plans of Action.

NOAA's fishery and technical experts helped develop criteria (since adopted by FAO and accepted as worldwide standards) for defining overcapacity in marine fisheries. Nevertheless, progress has been slow in persuading many nations to implement capacity reduction measures.

Recommendation 19–25. The National Oceanic and Atmospheric Administration, working with the U.S. Fish and Wildlife Service and the U.S. Department of State, should design a National Plan of Action for the United States that implements, and is consistent with, the International Plans of Action adopted by the United Nations Food and Agriculture Organization and its 1995 Code of Conduct for Responsible Fisheries. This National Plan should stress the importance of reducing bycatch of endangered species and marine mammals.

Recommendation 19–26. The international committee of the National Ocean Council (discussed in Chapter 29), should initiate a discussion to determine the most effective methods of encouraging other nations to implement the United Nations Food and Agriculture Organization's Code of Conduct for Responsible Fisheries and other Plans of Action and provide its findings to the U.S. Department of State and the National Ocean Council.

In particular, the international committee should suggest methods to encourage nations to:

- *join relevant regional fishery management organizations.*
- *implement and enforce regional agreements to which they are bound.*
- *reduce or eliminate illegal, unreported, and unregulated fishing by ships flying their flag.*
- *reduce their fishing fleet capacity, particularly on the high seas.*
- *reduce bycatch of non-targeted species, in particular endangered populations such as sea turtles and marine mammals, via the use of innovative gear and management methods (such as onboard observer programs).*

The international committee should consider potentially effective incentives such as greater access to U.S. markets, bilateral aid, debt forgiveness, subsidies, and preferential loans for cooperating nations, as well as disincentives for those that do not implement these agreements.

International Fisheries and Trade

Intentional and unintentional harm to marine mammals and endangered species remain major problems at the global level. Large populations of sea turtles, dolphins, sharks, and seabirds are unintentionally caught in the huge nets used by shrimp and tuna fishermen. And the global trade in endangered species continues.

In the 1990s the United States attempted to employ trade sanctions to combat damaging harvesting practices. Such sanctions can be very effective when the nation imposing them is a major importing market. In response to a recent U.S. initiative, but amid considerable dispute, the FAO established an informal consultative process to consider greater cooperation between its fishery management activities and the Convention on International Trade in Endangered Species of Wild Fauna and Flora, which regulates global trade in endangered species.

Not surprisingly, the World Trade Organization (WTO) generally discourages nations from taking unilateral trade action, arguing that it undermines free trade. But the WTO has also recognized that conservation can be a legitimate objective of trade policy. When the United States banned the import of certain shrimp products from nations whose harvesting practices resulted in a large bycatch of sea turtles, a complaint was filed at the WTO. Although the WTO ultimately ruled against the United States on procedural grounds, it affirmed that the ban served a legitimate conservation objective under the General Agreement on Tariffs and Trade. The United States should continue to press for the inclusion of environmental objectives—particularly those specified in international environmental agreements—as legitimate elements of trade policy.

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Chapter 20: Protecting Marine Mammals and Endangered Marine Species

Protection for marine mammals and endangered or threatened species from direct impacts has increased since the enactment of the Marine Mammal Protection Act in 1972 and the Endangered Species Act in 1973. However, lack of scientific data, confusion about permitting requirements, and failure to adopt a more ecosystem-based management approach have created inconsistent and inefficient protection efforts, particularly from indirect and cumulative impacts. Consolidating and coordinating federal jurisdictional authorities, clarifying permitting and review requirements for activities that may impact marine mammals and endangered or threatened species, increasing scientific research and public education, and actively pursuing international measures to protect these species are all improvements that will promote better stewardship of marine mammals, endangered or threatened species, and the marine ecosystem.

Assessing the Threats to Marine Populations

Because of their intelligence, visibility and frequent interactions with humans, marine mammals hold a special place in the minds of most people. Little wonder, then, that mammals are afforded a higher level of protection than fish or other marine organisms. They are, however, affected and harmed by a wide range of human activities.

The biggest threat to marine mammals worldwide today is their accidental capture or entanglement in fishing gear (known as "bycatch"), killing hundreds of thousands of animals a year.[1] Dolphins, porpoises and small whales often drown when tangled in a net or a fishing line because they are not able to surface for air. Even large whales can become entangled and tow nets or other gear for long periods, leading to the mammal's injury, exhaustion, or death. (These issues are also discussed in Chapter 18 on marine debris and Chapter 19 on fisheries management.)

Historically, commercial harvesting contributed to major declines in the populations of marine mammals but only a few nations still allow hunting for purposes other than subsistence. Hunters from those nations continue to kill hundreds of thousands of whales, dolphins, and other marine mammals each year while legal subsistence hunting accounts for thousands more.

Like pedestrians in the city, marine mammals are vulnerable to ship traffic at sea, especially in areas crowded by commercial and recreational vessels. North Atlantic right whales are particularly susceptible to collisions with vessels in busy East Coast corridors, while manatees are frequently struck by boats in shallow waters near Florida. Several hundred animals are wounded or killed by such interactions every year.

Other possible causes of mortality include the indirect effects of climate change, introduction of new diseases, and ecosystem changes such as algal blooms. These factors may cause several thousand additional deaths each year.

Although pollution rarely kills marine creatures immediately, it can impair their health, harm their reproductive potential, and eventually lead to their death. Chemicals in fertilizers, pesticides, pharmaceuticals, and other materials can accumulate in the tissues of these animals, especially those with long life spans, such as sea turtles. Ingestion of ocean debris and entanglement in plastic trash are additional dangers for marine mammals, sea turtles, and sea birds.

Marine mammal populations may also be disturbed by noise from shipping, oil and gas exploration, ocean drilling, naval operations, oceanographic and geophysical research, and similar activities. In the last ten years, considerable publicity has surrounded the deaths of marine mammals in close proximity to U.S. naval operations and geophysical research vessels. Unfortunately, very little is known about marine mammal hearing, making it difficult to assess the potential bio-physical impacts of noise on marine animals.

The threats to endangered marine species such as sea turtles and sea birds are myriad and not easily categorized. One factor that is common to declines in many species is the destruction or degradation of their natural habitat. Thus the successful recovery of a species depends to a large degree on protection or restoration of this habitat.

Reviewing Authorities and Responsibilities

The early 1970s witnessed the passage of several landmark environmental laws in the United States. Many of these statutes affected marine mammals and other protected species indirectly, but two were focused specifically on the conservation and protection of these animals.

The Marine Mammal Protection Act

The 1972 Marine Mammal Protection Act (MMPA) was passed by Congress in response to public concerns about the incidental deaths of hundreds of thousands of dolphins each year associated with tuna fisheries, the hunting of seals for fur, and the continuing commercial harvest of whales despite controls by the International Whaling Commission. The MMPA, with limited exceptions, prohibits the hunting, killing, or harassment of marine mammals.

The MMPA divides federal jurisdiction over marine mammals between two agencies. The National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) manages the vast majority of marine mammals, including whales, dolphins, porpoises, seals, and sea lions. The U.S. Department of the Interior's (DOI's) U.S. Fish and Wildlife Service (USFWS) manages five species: polar bears, walrus, sea otters, manatees, and dugongs.

The MMPA also established the independent Marine Mammal Commission (MMC). The MMC is charged with reviewing and making recommendations on domestic and international actions and policies of all federal agencies with respect to marine mammal protection and conservation. It also manages and funds a research program to support management activities. Although the Commission's independence has been essential to its functioning, creation of the National Ocean Council will provide it with a venue to coordinate with other federal agencies involved in marine mammal research and management. According to the MMC, most marine mammal stocks in U.S. waters, and many others around the world, are in better condition now than before passage of the MMPA.[2]

Recommendation 20–1. Congress should amend the Marine Mammal Protection Act to require the Marine Mammal Commission to coordinate with all the relevant federal agencies through the National Ocean Council (NOC) while remaining independent. The NOC should consider whether there is a need for similar oversight bodies for other marine animals whose populations are at risk.

The Endangered Species Act

In 1973, the Endangered Species Act (ESA) was enacted to conserve endangered and threatened species and the ecosystems upon which they depend. The new law vastly strengthened earlier measures directed at the same problem. The public was broadly supportive of the Act due to the well-publicized declines of well-known species such as the bald eagle. A 1999 public opinion survey indicated that public support for the protection of biodiversity continues.[3]

Under the ESA, the federal government is responsible for listing species as "endangered" or "threatened" based on population size and trends. This responsibility is divided between the USFWS, primarily responsible for terrestrial organisms, and NMFS, primarily responsible for marine and anadromous species. The law includes powerful prohibitions against any action that harms a listed animal. The law, with limited exceptions, prohibits federal agencies from authorizing, funding, or carrying out any action that would jeopardize a member of a listed species or destroy its critical habitat and requires them to undertake conservation programs. To promote state action, matching federal funds were authorized for states willing to enter into approved cooperative agreements.

Currently, there are 1,509 species listed as endangered and 345 species listed as threatened by USFWS, while NMFS has listed 19 species as endangered and 12 as threatened. It is impossible to precisely quantify the overall biological impact of the ESA. However, a 1995 National Research Council (NRC) report concluded that the ESA has successfully prevented species from becoming extinct.[4] The rigorous provisions of the ESA work as a safety net to help species survive once they have declined to the level that listing is warranted. Because of this, the NRC did not recommend wholesale changes to ESA implementation. It did, however, point out that the ESA has been less effective in preventing species from declining to levels that require listing in the first place.

The NRC also observed that, although one purpose of the ESA is to conserve ecosystems, the Act itself includes little specific guidance in this area. To fix this, the NRC recommended a focus on broader rehabilitation of ecosystem functions, as part of a move toward ecosystem-based management. Maintaining healthy, functioning ecosystems can help prevent species from becoming threatened or endangered and avoid some of the economic disruption that results when drastic measures must be taken to protect an endangered species. The NRC report also concluded that the federal focus of the ESA should be broadened to include other layers of government and nongovernmental interests as well. Of course, humans themselves are part of the ecosystem and comprehensive management plans should account for both species conservation and human uses.

Identifying and Overcoming Gaps in Protection

Several changes are needed in federal law to enhance marine mammal and endangered species protection. The split of management jurisdiction between two federal agencies, confusion over the requirements of permit applications and approvals, and the lack of clarity in the definition of legal terms are all issues that should be addressed.

Jurisdictional Confusion

As noted, the management of marine mammals and endangered species is currently divided between NMFS and USFWS. In the case of marine mammals, this split was intended to be temporary and makes little sense. In the case of endangered species, the split is more logical, but better coordination and clarity are still needed.

The original congressional committee reports that accompanied the MMPA in 1972 show that Congress did not intend marine mammal jurisdiction to be permanently divided between NOAA and USFWS.[5,6] Rather, House and Senate committees anticipated the creation of a new Department of Natural Resources that would combine NOAA and USFWS. The report stated that if the proposed new department did not become a reality, they would reexamine the question of jurisdiction and consider placing the entire marine mammal program within a single department. Nevertheless, the jurisdictional split remains today.

The division of endangered species jurisdiction appears reasonable because of the expertise of each agency: NMFS has jurisdiction over marine and anadromous species and DOI has jurisdiction over terrestrial and freshwater species. But ecosystems do not recognize these distinctions. When some species of salmon were listed under the ESA in the 1980s and 1990s, most of the causes for their decline were land-based or freshwater in origin, requiring significant coordination between NMFS and USFWS, as well as other agencies. This coordination has not been entirely effective and improved oversight of the relationship between NMFS and USFWS is needed to clarify areas of responsibility and reduce conflicts.

Recommendation 20–2. Congress should amend the Marine Mammal Protection Act to place the protection of all marine mammals within the jurisdiction of the National Oceanic and Atmospheric Administration.

Recommendation 20–3. The National Ocean Council should improve coordination between the National Marine Fisheries Service and U.S. Fish and Wildlife Service with respect to the implementation of the Endangered Species Act, particularly for anadromous species or when land-based activities have significant impacts on marine species.

Unclear Permitting and Review Standards

A *take* is a term used in the MMPA and ESA to define an activity that results in the death or injury of a marine mammal or a member of an endangered species. After much litigation and scrutiny, the interpretation of this term under the ESA appears fairly clear to both managers and the public. This is not the case for the MMPA.

The MMPA prohibits the taking or importation of marine mammals and marine mammal products unless that action falls under one of the law's exemptions, such as a taking for the purpose of education, conservation, or scientific research. Exemptions are also allowed for Native Alaskans, who may take marine mammals for subsistence or for creating authentic native handicrafts and clothing.

Outside these narrow exemptions, the MMPA authorizes the issuance of permits for the unintentional and incidental taking of small numbers of marine mammals provided it has only a negligible impact on the species. This provision has been problematic because terms such as *small numbers* and *negligible impact* are not defined in the Act, resulting in a lack of clarity about when a permit is necessary and under what circumstances it should be granted.

Recommendation 20–4. Congress should amend the Marine Mammal Protection Act to require the National Oceanic and Atmospheric Administration to more clearly specify categories of activities that are allowed without a permit, those that require a permit, and those that are prohibited.

The Meaning of Harassment

Under the MMPA, the term *harassment* is an essential element in determining whether a small-take permit can be granted. Amendments to the Act in 1994 split the definition of harassment into two categories. Harassment is currently defined in law as any act of pursuit, torment, or annoyance that:

- has the potential to injure a marine mammal or marine mammal stock in the wild (level A harassment), or
- has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (level B harassment).

The apparent intent of this definition was to distinguish activities likely to have significant effects from activities such as marine mammal research that, although perceptible to the animals, are not likely to result in significant disturbance. However, NOAA and USFWS have had difficulties implementing the 1994 definition which has led to public uncertainty with respect to its implications. The lack of clarity means that almost any commercial, recreational, or scientific activity that is noticed by a marine mammal might be defined as harassment. Paradoxically, this uncertainty has provided *less* protection; neither agency has ever brought an enforcement case under the new definition. In fact, both agencies argue that the confusion limits their ability to regulate even potentially harmful activities.

A 2000 National Research Council report concluded that the intent of the MMPA was not to regulate activities that result in minor changes in behavior.[7] The report recommended that level B harassment be redefined to focus on "meaningful disruptions to biologically significant activities." Another National Research Council study currently underway is investigating what behaviors should be considered biologically significant and what research might be needed to implement the revised definition.

Recommendation 20–5. Congress should amend the Marine Mammal Protection Act to revise the definition of harassment to cover only activities that meaningfully disrupt behaviors that are significant to the survival and reproduction of marine mammals.

The Promise of Programmatic Permitting

In spite of the confusion about MMPA wording, NMFS and USFWS have had to issue regulations and make case-by-case decisions on permit and authorization applications. Considerable deference has been given to the professional judgment of agency personnel regarding which activities are permissible. Both agencies have qualified and dedicated people reviewing applications, but the process is necessarily subjective and a personnel change can mean the difference between approval and denial of similar permits. This case-by-case decision making has led to inconsistencies, a lack of clear standards, and uncertain protection for marine mammals.

Most permit applications are processed according to the same procedures, regardless of the level of potential harm to marine mammals. As a result, limited agency resources can be wasted reviewing relatively insignificant permit applications, while insufficient attention is paid to more worrisome activities. A shift to programmatic permitting would enable more proactive and efficient handling of the bulk of permit applications, while reducing the costs and burdens on agency personnel.

Programmatic permitting would allow for quick approval of activities on a defined list, specifying broad parameters within which those activities could occur. A programmatic permit could also include required mitigation and data collection measures, such as requiring that whale-watching boats keep at a certain distance from the animals and maintain records of species observed and their locations.

In addition to streamlining permitting, clear and consistent enforcement is needed to ensure compliance with permit conditions, and penalties must be stiff enough to discourage anyone tempted to disregard those conditions.

Recommendation 20–6. The National Marine Fisheries Service and the U.S. Fish and Wildlife Service should implement programmatic permitting for activities that affect marine mammals, wherever possible. More resource intensive case-by-case permitting should be reserved for unique activities or where circumstances indicate a greater likelihood of harm to marine mammals. The National Ocean Council should create an interagency team to recommend activities appropriate for programmatic permitting, those that are inappropriate, and those that are potentially appropriate pending additional scientific information. Enforcement efforts should also be strengthened and the adequacy of penalties reviewed.

To carry this out:

- *the interagency team should include representatives from the National Oceanic and Atmospheric Administration, National Science Foundation, U.S. Army Corps of Engineers, Minerals Management Service, and U.S. Navy, with input from the Marine Mammal Commission.*
- *programmatic permits should be subject to periodic review, be updated to incorporate the best available science, and remain valid for a limited time to ensure that current permittees are bound by any changes.*

While programmatic permitting would reduce much of the uncertainty about whether a permit is required, some cases will continue to be unclear. Potential permittees should approach the regulatory agencies as soon as a question arises about possible interactions with marine mammals. In particular, the potential impacts of new ocean technologies on marine mammals should be considered and the permit application process started early in the developmental stages.

Communication must also be improved so that permitting agencies have sufficient time and resources to meet their responsibilities while the action agency or permit applicant can be sure that decisions will be made in a confidential, timely and consistent manner. This has been a particular problem in the past with regard to naval exercises and oceanographic research activities.

EXPANDING RESEARCH AND EDUCATION

Although much more is known about marine animals today than even a decade ago, scientists still do not understand the life history or physiology of most marine mammal species. Because the decline of such populations tends to be caused by multiple environmental factors, enhanced research on a range of subjects is necessary to find ways to reduce the harmful effects of human activities and to implement effective ecosystem-based management plans.

Understanding Behavior and Human Impacts

Minimizing disruptions to the most important life stages of marine mammals will aid in their survival. To maximize reproductive rates in declining populations, more needs to be learned about breeding grounds and essential habitat. If information were available that showed a particular species could benefit from higher levels of protection during times of mating or birth, management practices could evolve accordingly. Actions could include temporarily closing fisheries that overlap with these activities or requiring vessel traffic to slow down or avoid critical areas. Knowledge of migration patterns and feeding locations is also critical to maintaining healthy populations.

While many human activities can harm individual marine animals, the extent to which humans affect the long-term status of protected species is poorly understood. Coastal development, offshore oil and gas exploration, vessel traffic, military activities, and marine debris all have the potential to threaten protected populations. Understanding the danger of these activities relative to bycatch, hunting, and natural predation is critical to focus attention, research, and enforcement efforts where it is most needed.

Point and nonpoint source pollution threaten the health of all ocean organisms. Much more study is needed about the effects of contaminants, especially on marine mammals' immune functions, and the possible results of exposure to human pathogens and toxic algal blooms. In addition, the differing impacts of chronic versus acute exposures need to be measured—long-term exposure to relatively low levels of some pollutants may be more damaging to a population's continued success than a single, high-impact event.

Increased research into the biological, chemical, and psychological stresses to marine mammal and other protected species populations will allow for more comprehensive, ecosystem-based management. Furthermore, for activities where interaction with protected populations is likely and unavoidable, better scientific data will lead to more effective permitting procedures.

Recommendation 20–7. The National Oceanic and Atmospheric Administration and the U.S. Department of the Interior should promote an expanded research, technology, and engineering program, coordinated through the National Ocean Council, to examine and mitigate the effects of human activities on marine mammals and endangered species.

Effects of Noise on Marine Mammals

One particular area that requires better understanding is the effect of sound on marine mammals. Many marine mammals use sound to communicate, navigate, feed, and sense their surroundings. These natural behaviors can be disrupted when other sounds interfere. In the ocean, sound emanates from a variety of sources, both natural (e.g., storms, volcanic eruptions, and earthquakes) and human-generated (e.g., shipping, scientific and commercial surveys, and commercial and military sonar).

Scientists know relatively little about the biological, psychological, and behavioral changes in marine mammals that are caused by human-generated sound. Activities such as commercial shipping, construction, geological exploration, and sonar certainly can produce noises intense enough to elicit reactions from marine mammals. However, due to the complexity of the biological and physical interactions being studied, and the difficulty of conducting studies on marine mammals, many important questions remain unanswered.[8] For example, the scientific community currently understands very little about marine mammal hearing and how these animals react to sound. It is not known whether health and behavioral problems will arise only from acute exposures to very loud sound, or whether chronic exposure to lower-intensity sounds (such as passing ship traffic) may also result in long-term effects.

Currently, the U.S. Navy and, to a lesser extent, the Minerals Management Service, are the only federal agencies with significant marine mammal acoustic research programs, including studies to examine the impact of noise on marine mammals. Expanded research efforts and data dissemination are needed to understand marine mammal interactions with sound and reduce or prevent the negative impacts of human-generated noise on these animals.

Recommendation 20–8. Congress should expand federal funding for research into ocean acoustics and the potential impacts of noise on marine mammals. This funding should be distributed across several agencies, including the National Science Foundation, U.S. Geological Survey, and Minerals Management Service, to decrease the reliance on U.S. Navy research in this area. The research programs should be well coordinated across the government and examine a range of issues relating to noise generated by scientific, commercial, and operational activities.

Public Education and Outreach

The general public increasingly has opportunities to come into contact with marine mammals through diving, aquarium shows, and similar activities. These interactions can increase public awareness and sensitivity about the needs and vulnerabilities of these animals and how human activities can affect them. Aquariums and other marine mammal exhibitors can also showcase how larger environmental issues affect marine mammals and the ecosystems on which they rely.

While human contact with marine mammals raises public awareness, there is also growing concern about activities such as feeding programs, whale-watching excursions, and facilities that allow humans to swim with captive dolphins. For example, feeding programs in the open ocean, most prevalent in Florida and Hawaii, can disrupt natural behaviors and expose animals to harm by decreasing their natural fear of humans.[9] Education programs should point out the harm that too much human interaction with marine mammals can inadvertently cause.

APPLYING ECOSYSTEM-BASED MANAGEMENT PRINCIPLES

The purpose of ecosystem-based management approaches is to recognize the full nature of ocean and coastal systems and to allow for better coordination of management actions, reduce duplication and conflicts, and take full advantage of available resources. As they are implemented, ecosystem-based management practices can enhance the protection of marine mammals and endangered species.

Domestic Action

The MMPA and ESA currently provide powerful statutory and regulatory tools to address direct impacts to marine mammals and endangered species. However, mechanisms are not in place for handling broad, long-term threats and concerns. The basic tenets of ecosystem-based management require an assessment of all important components and processes in a system, and evaluation of all potential threats. Improved scientific assessments will allow managers to create ecosystem-based management plans, an essential part of which would describe threats to marine mammals and other protected species. Once an ecosystem is analyzed, managers can prioritize protection efforts, addressing the most critical risks first.

For marine mammals, hunting and fisheries bycatch would be at the top of the list; for endangered species, habitat destruction would be a likely focus. Unfortunately, attention has centered instead on high-profile lower impact issues, such as the possible effect of ocean noise on marine mammals. Part of the explanation for the misdirected focus is the huge disparity between what we know about the biology and ecology of marine species and what remains to be learned. In particular, the lack of baseline data on marine mammal biology coupled with limited stock assessment data make it difficult to evaluate population abundance and trends or distinguish management successes and failures.

The listing of several salmon species as endangered and threatened shows both the promise and the difficulty of moving toward an ecosystem-based management approach. The threat of large-scale economic disruptions in the Pacific Northwest has led many state, local, and tribal entities to push for a more collaborative, ecosystem-based management approach to avoid severe federal sanctions under the ESA. However, initial results have shown that the federal government needs to do a better job of supporting and encouraging these efforts. Recommendations in Chapter 3 on ecosystem-based management and in Chapter 5 on the benefits of a regional approach should help.

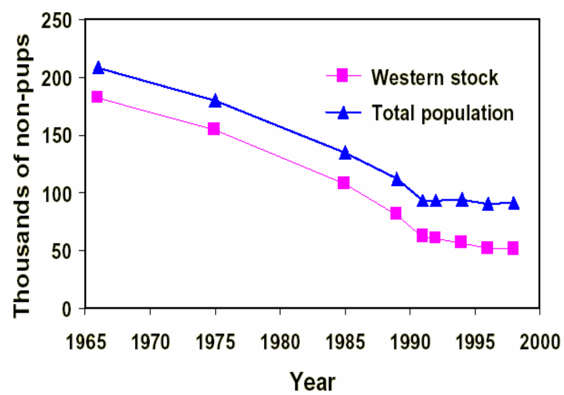
International Coordination

Expanding the concept of ecosystem-based management to its logical conclusion will require us to address impacts that occur beyond U.S. waters. For many of the marine species discussed in this chapter, the ecosystem in which they live encompasses the high seas and also the waters of many other countries around the world. In order to address impacts to these species throughout their ecosystem, the United States will need to use international agreements and other diplomatic means to strengthen protections for species beyond our own waters. For example, the development of bycatch reduction methods for U.S. fishermen should be complemented by efforts to get foreign fishermen to implement similar methods. This comprehensive approach makes sense from a conservation perspective and creates a more level playing field for U.S. and foreign fishermen. The U.S. Department of State, working with NOAA and DOI, should continue to actively pursue efforts to reduce the impacts of human activities on marine species at risk in international and foreign waters.

Making a Case for Ecosystem-based Management: The Steller Sea Lion

The story of the Steller sea lion illustrates the conflicts that can arise between human activities and protection of marine mammals. The Steller sea lion is the largest of the sea lions and is found along coastal areas of the northern Pacific Rim. Its primary sources of food are groundfish, including pollock and mackerel, and cephalopods, including octopus and squid. Since the mid-1970s, the western population near Alaska has declined by about 85 percent (Figure 20.1).[10] Analyses indicate that the decline may be due in part to environmental changes, legal and illegal hunting, predation by killer whales, competition with fishermen for food, and incidental catch in fisheries. A 2003 report by the National Research Council found that none of these causes could be ruled out and called for scientifically-designed adaptive management experiments to find out more.[11]

Figure 20.1. Sea Lion Populations in Danger



Even though Steller sea lions have been protected since the early 1970s, the Alaskan populations of animals over one year old (non-pups) have continued to decline, particularly those located along the Aleutian Islands. This decline cannot be traced to a single cause, underscoring the need for an ecosystem-based approach to protect these animals.
Source: National Oceanic and Atmospheric Administration. <http://stellersealions.noaa.gov/> (Accessed January, 2004).

Under the Marine Mammal Protection Act, the national Marine Fisheries Service (NMFS) is responsible for managing Steller sea lions. It is also the agency responsible for management of Alaskan fisheries, resulting in potential statutory conflicts. In 1991, a number of environmental groups sued NMFS for failing to take into account the potential role of Alaskan fisheries in the decline of the Steller sea lion. After years of litigation, the problem has yet to be resolved to the satisfaction of any of the litigants. In addition, Steller sea lions were listed under the Endangered Species Act (the western population as endangered and the eastern as threatened) adding that statute's requirements to the mix.

The continued decline of the Steller sea lion population highlights the importance of moving toward an ecosystem-based management approach, where such factors as predators, quality and quantity of food, essential habitat, and incidental catch are all weighed when deciding the best course of action for protection of a species. In addition, a more ecosystem-based focus would have identified the problem much more quickly, enabling managers and scientists to develop a more comprehensive and timely research strategy to determine the various causes of the decline and develop a management regime to address the problems. Instead, the situation was allowed to reach a crisis stage, requiring emergency measures.

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[8] Ibid.
[9] Spradlin, T.R., et al. "Interactions between the Public and Wild Dolphins in the United States: Biological Concerns and the Marine Mammal Protection Act." Presented at the 13th Biennial Conference on the Biology of Marine Mammals. Maui, HI, November 1999.
[10] Marine Mammal Commission. *Annual Report to Congress*. Washington, DC, 2002.
[11] National Research Council. *The Decline of the Steller Sea Lion in Alaskan Waters: Untangling Food Webs and Fishing Nets*. Washington, DC: National Academy Press, 2003.

Chapter 21:
Preserving Coral Reefs And Other Coral Communities

Coral reefs and other coral communities are beautiful and diverse, as well as biologically and economically valuable. In addition to well-known tropical coral reefs, coral communities can also be found in deep waters and at high latitudes. Increasingly, coral reefs and other coral communities are facing threats from a number of natural and human-induced causes. To conserve these unique ecosystems, comprehensive coral reef protection and management legislation is needed to address research, protection, and restoration of coral ecosystems. A strengthened U.S. Coral Reef Task Force should lead and coordinate federal coral management efforts. The United States must continue to be a leader in coral management at the international level, including promoting the development of international standards for sustainable harvesting of coral reef resources. Finally, improved research and data collection are critical to better understand coral ecosystems and the impacts of human activities on them.

Assessing the Status of Coral Ecosystems

Coral reefs are formed from layers of calcium carbonate deposited over time by colonies of individual corals. These reefs provide homes for tens of thousands of species of marine plants and animals, making them among the world's most diverse and productive habitats. Nearly one-third of all fish species live on coral reefs,[1] while other species depend on the reefs and nearby seagrass beds and mangrove forests for critical stages of their life cycles.

The Distribution of Coral Ecosystems

Most coral reefs are found in shallow, clear ocean waters in tropical and semitropical areas. These warm-water corals derive significant food and energy from photosynthetic algae that live in symbiosis with the corals. Warm-water corals have raised intense interest in the last decade because of their apparent sensitivity to climate variability.

Other corals that do not depend directly on sunlight can form reef-like structures or banks at depths from one-hundred feet to more than three miles below the ocean's surface. While little is known about these deep-water structures, many scientists believe that their biological diversity may rival that of coral communities in warmer, shallower waters.[2]

Coral reefs are found in the waters of more than one-hundred countries, including the United States (Figure 21.1). They are particularly abundant in the South Pacific; Indonesian waters are estimated to include the largest proportion of corals, approximately 18 percent of the global total. U.S. waters include 1–2 percent of global warm-water corals.[3] Deep-water corals have been found around the globe, although little is known about their actual extent.

The National Oceanic and Atmospheric Administration (NOAA) estimates that U.S. coral reefs cover approximately 7,600 square miles. These reefs can be found in western Atlantic and Caribbean waters off Florida, Puerto Rico, the U.S. Virgin Islands, the Navassa Island National Wildlife Refuge (a small U.S. island territory near Haiti), and in the Pacific Ocean near Hawaii, American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, and several remote, unincorporated Pacific island areas. Estimates of coral reef extent in the Pacific Freely Associated States (Palau, the Federated States of Micronesia, and the Marshall Islands) range from 4,500 to 31,500 square miles.[4]

Figure 21.1. The Warm Water of the Tropics Is Home to the Majority of Known Reefs

The locations of major coral reefs are seen as dots on this world map (reef area is not to scale). Most of the world's known reefs are found in tropical and semitropical waters, between 30° north and 30° south latitudes, although scientists have only begun to explore other cold-water coral communities.

Source: National Oceanic and Atmospheric Administration. <http://www.coris.noaa.gov> (Accessed January, 2004).

The Value of Coral Ecosystems

Coral reefs are valued for their rich biological diversity as well as for the important ecosystem functions they serve. Reefs buffer shorelines from storms and erosion and provide homes, food, and nursery areas for tens of thousands of species of marine life. They are also the basis of thriving commercial and recreational fishing and tourism industries, and have the potential to provide beneficial medical applications. Coral reef ecosystems are estimated to provide a worldwide total of $375 billion a year in goods and services, with approximately 500 million people dependent on these ecosystems for food, materials, or income.[5] In 2001, coral reefs in the Florida Keys alone supported $105 million in income and more than 8,000 jobs.[6] Further, approximately one-half of all federally managed commercial fish species depend on coral reefs for at least part of their life cycle.[7]

Many people also value coral reefs for their unique aesthetic and cultural value. Coral reefs are an important part of the heritage of many countries, and the use of reef resources is integral to the social fabric of coastal communities. As one of the longest-lived and most beautiful ecosystems on Earth, their intrinsic value is incalculable.

Threats to Coral Ecosystems

Coral reefs are declining at a disturbing pace.[8] The causes of this decline are varied, particularly for warm-water reefs. Many scientists believe that excessive fishing pressure has been the primary threat to coral ecosystems for decades.[9] However, pollution and runoff from coastal areas also deprive reefs of life-sustaining light and oxygen, and elevated sea surface temperatures are causing increasingly frequent episodes of coral bleaching and appear to be exacerbating other coral disease outbreaks.[10] Although little is known about the condition of the world's deep-water coral communities, extensive damage has been documented in some areas, with fishing activities suspected as being the largest human-related threat.[11]

Worldwide, no pristine, undamaged warm-water coral reefs remain, and one-third of the world's identified reefs are severely damaged.[12] In the United States, every warm-water reef system has suffered varying degrees of impacts from natural and human disturbances. Only the coral reefs in the Northwest Hawaiian Islands are in near-pristine condition, although they too have begun to show signs of damage, particularly from marine debris. In the U.S waters of the south Atlantic, Gulf of Mexico, and Caribbean, two-thirds of reef fish species are overfished. In addition, during the 1990s, white band disease killed 90–96 percent of the most common nearshore species of corals.[13]

Coral communities have existed for millions of years and have developed mechanisms to cope with natural threats such as hurricanes, landslides, and predation. Often, when one part of a coral community is damaged, the overall functioning of the coral reef ecosystem is sustained by other, untouched communities that are able to repopulate damaged areas. However, the point is fast approaching where this natural cycle of repair may not be able to keep pace with the increasing rate of damage. Without immediate and large-scale protection from the cumulative impacts of a multitude of human activities, many reefs, particularly those located near heavily populated coastal areas, may soon be irretrievably harmed.[14]

Managing U.S. Coral Resources

Federal Agency Roles and Responsibilities

Although a number of longstanding environmental laws can be applied to the protection of coral reefs, the first legislation specifically targeted at coral reef issues, the Coral Reef Conservation Act, was passed in 2000. The Act focuses primarily on NOAA activities, requiring the agency to develop a national coral reef action strategy, initiate a matching grants program for reef conservation, and create a conservation fund to encourage public–private partnerships.

The Marine Protection, Research, and Sanctuaries Act (MPRSA) also provides protection for many coral reefs by authorizing NOAA to designate areas as marine sanctuaries and promulgate regulations for the conservation and management of those areas. Since the Act was passed in 1972, thirteen sanctuaries have been designated, several of which contain coral communities. Coral research, monitoring, and management activities are conducted in these sanctuaries, as well as in the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, which is currently under consideration to become the nation's fourteenth sanctuary.

The MPRSA includes a provision that allows NOAA to fund repairs to damaged habitats within sanctuaries, with cost recovery from responsible parties. However, the Act only allows funding for projects to repair immediate damage. For example, if a ship hits a reef, funds may be used to repair the damaged site, but not to install navigational aids to prevent other ships from damaging the reef in the future. Further, the funds cannot be used to remedy long-term chronic damages from pollution, nutrient overloading, or disease.

Other federal laws that are used to manage and protect coral reef resources include the following (a description of these and other federal statutes are included in Appendix D):

- The Magnuson–Stevens Fishery Conservation and Management Act, which allows for management of coral harvest and provides limited protections for corals if they are designated as "essential fish habitat."
- The Coastal Zone Management Act, which provides for management of shoreline areas that may include coral reefs.
- The Clean Water Act, which regulates the discharge of dredged or fill materials into U.S. waters.
- The Sikes Act, which requires the U.S. Department of Defense to provide for conservation and rehabilitation of natural resources on military installations, which in some locations include corals.
- The Endangered Species Act, National Environmental Policy Act, and Lacey Act, all of which contain some provisions that can be applied to the protection of corals.

Responsibility for implementing these and other laws with implications for coral reef management is shared by a number of federal agencies. For example, the U.S. Environmental Protection Agency and the U.S. Department of Agriculture have regulatory and management responsibilities related to pollution from land-based sources. NOAA has the authority to regulate fishing in coral reef ecosystems. And action on global climate change is under the purview of many agencies, including the U.S. Department of Energy and the U.S. Department of State.

Interagency and Intergovernmental Coral Reef Management Initiatives

The U.S. Coral Reef Task Force

The U.S. Coral Reef Task Force was created by Executive Order in 1998 with the purpose of improving coordination among the many agencies that manage various aspects of the nation's coral reef resources. Task force responsibilities include developing strategies to map and monitor U.S. coral reefs, studying the causes of and recommending solutions for coral reef degradation, and promoting conservation and sustainable use of coral reefs at the international level. Several broad action plans have been developed by the task force, although not all have been implemented.

The task force, which is co-chaired by the U.S. Departments of the Interior and Commerce, works primarily through consensus building among its member federal agencies and state and territorial government representatives. Two notable absences from the task force are the Department of Energy and the U.S. Army Corps of Engineers (USACE). The Department of Energy is actively involved in investigating the impact of global climate change on coral reefs. In addition, coral reefs are affected by many USACE projects, such as the construction of inland and shore structures, beach nourishment programs, and mooring permits.

The U.S. All Islands Coral Reef Initiative

The U.S. All Islands Coral Reef Initiative, a cooperative effort among Hawaii, American Samoa, Guam, the Commonwealth of Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands, is working to improve the management of coral reefs in island areas. Regional approaches that incorporate traditional knowledge are of particular interest to these islands, many of which share common cultural concerns about coral reef resources and manage similar threats, such as erosion, sea level rise, and degraded water quality.

Improving the Management of U.S. Coral Resources

Despite recent management efforts, the health of coral reef ecosystems is continuing to decline at a rapid pace, demanding that further action be taken to overcome gaps and inefficiencies in the existing patchwork of laws, regulations, and agency programs. An improved governance regime is needed to better respond to coral reef management priorities at all levels (local, state, territorial, regional, and national), improve coordination among agencies, facilitate regional approaches, and implement national action on coral reefs. This regime should build on existing ideas and strategies of the U.S. Coral Reef Task Force, the U.S. All Islands Coral Reef Initiative, the Coral Reef Conservation Act, and the Marine Protection, Research, and Sanctuaries Act and task federal agencies with promulgation and enforcement of effective regulations to protect coral reef resources. Concerted support among all levels of government and increased public awareness are also essential for successfully implementing improved management strategies to achieve and sustain healthy coral reef ecosystems.

Recommendation 21–1. Congress should pass, and provide sustained funding for, a Coral Protection and Management Act that covers research, protection, and restoration of coral ecosystems.

This legislation should include the following elements:

- *support for mapping, monitoring, and research programs primarily through the National Oceanic and Atmospheric Administration and the U.S. Coral Reef Task Force.*
- *support for new research and assessment activities to fill critical information gaps, to be carried out in partnership with the academic research community.*
- *liability provisions for damages to coral reefs similar to those in the Marine Protection, Research, and Sanctuaries Act, but with greater flexibility to use funds in a manner that provides maximum short- and long-term benefits to the reef.*
- *support for outreach activities to educate the public about coral conservation and reduce human impacts.*
- *support for U.S. involvement, particularly through the sharing of scientific and management expertise, in bilateral, regional, and international coral reef management programs.*

In addition to new legislation directed specifically at improving the management of the nation's coral reef resources, a strengthened U.S. Coral Reef Task Force is needed to improve collaborative efforts at reducing the threats to these resources.

Recommendation 21–2. Congress should codify and strengthen the U.S. Coral Reef Task Force and place it under the oversight of the National Ocean Council.

The task force should be strengthened in the following ways:

- *Task force responsibilities should be expanded to include both warm-water and deep-water coral communities.*
- *the U.S. Department of Energy and the U.S. Army Corps of Engineers should be added as members of the task force.*
- *the task force should coordinate the development of regional ecosystem-based plans to address the impacts of nonpoint source pollution, fishing, and other activities on coral reef resources.*
- *the U.S. Environmental Protection Agency and the U.S. Department of Agriculture should work together to implement any pollution reduction goals developed by the task force.*
- *the National Oceanic and Atmospheric Administration, in consultation with Regional Fishery Management Councils, should implement any task force recommendations for reducing the effects of fishing on corals.*

Promoting International Coral Reef Initiatives

The United States has been a leader in the management of coral reef ecosystems at the international level. The State Department, NOAA, the U.S. Agency for International Development, and the U.S. Fish and Wildlife Service contribute significantly to building enhanced management capacity in developing countries through direct funding and through training in areas such as research, enforcement, management procedures, and environmentally sustainable harvesting techniques.

The United States also participates in many international initiatives that protect coral reef resources, including the Convention on International Trade in Endangered Species (CITES), an international agreement designed to protect species from over-exploitation by prohibiting trade with countries that cannot certify that their harvest of these species is not detrimental to their survival. Over 2,000 species of coral are listed under CITES. The International Coral Reef Initiative (ICRI) was developed in 1994 as an informal mechanism to develop the best strategies for conserving the world's coral reef resources. ICRI membership is made up of over eighty developing countries, donor countries, and development banks, international environmental and development agencies, scientific associations, the private sector, and nongovernmental organizations. ICRI's Global Coral Reef Monitoring Network has published the only global estimates of coral reef coverage and status, although the accuracy of these estimates could be improved.[15]

Creating More Sustainable Harvesting Practices

As the world's largest importer of ornamental coral reef resources,[16] the United States has a particular responsibility to help eliminate destructive harvesting practices and ensure the sustainable use of these resources. Many of these resources are harvested by methods that destroy reefs and overexploit ornamental species. A balance is needed between sustaining the legitimate trade in ornamental resources and sustaining the health and survival of the world's coral reef resources.

The Tropical Forest Conservation Act of 1998 offers a potential model for the role of the United States in curbing destructive harvesting practices. The Act authorizes the President to reduce debt owed to the United States if a developing country establishes a tropical forest management program and uses funds freed from the debt reduction agreement to support tropical forest conservation. Applying this type of program to the management of international coral reef resources could greatly enhance the ability of the United States to promote stewardship and conservation of coral reef ecosystems around the world.

Recommendation 21–3. The National Oceanic and Atmospheric Administration should develop national standards—and promote international standards—to ensure that coral reef resources that are collected, imported, or marketed are harvested in a sustainable manner. The U.S. Department of State should implement incentive programs to encourage international compliance with these standards.

Improving Understanding of Coral Ecosystems

Improved research and data collection activities are needed to better understand coral reef ecosystems and the impact of human activities on these ecosystems. The Integrated Ocean Observing System (IOOS), discussed in Chapter 26, is intended to become an integrated and continuous monitoring system encompassing all ocean environments, including coral communities. More finely tuned measurements of temperature and currents—and corresponding changes in coral communities—will allow scientists to understand and better predict the impacts of global climate change and other natural and human-induced events on coral communities. In addition, NOAA is working on a set of comprehensive maps of U.S. coral reefs that will incorporate an assessment of the current status of these reefs.

As the IOOS and other data collection programs (including the regional ocean information programs discussed in Chapter 5) move forward, the U.S. Coral Reef Task Force can provide guidance on information needs. This new information can then support further ecosystem-based research and management plans.

Recommendation 21–4. The U.S. Coral Reef Task Force should identify critical research and data needs related to coral reef ecosystems. These needs should guide agency research funding and be incorporated into the design and implementation of the Integrated Ocean Observing System.

The task force should:

- *develop regional, ecosystem-based research plans designed to protect and restore coral reef ecosystems, including deep-water coral communities.*
- *coordinate its efforts with the regional ocean information programs.*

[1] National Marine Fisheries Service. <http://www.nmfs.noaa.gov/prot_res/PR/coralhome.html> Accessed February, 2004.
[2] Oceana. *Deep Sea Corals*. Washington, DC, 2003.
[3] Global Coral Reef Monitoring Network. *Status of Coral Reefs of the World: 2002*. Ed. C. Wilkinson. Cape Ferguson, Queensland: Australian Institute of Marine Science, 2002.
[4] National Oceanic and Atmospheric Administration. *State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2002*. Silver Spring, MD, 2002.
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[8] Pandolfi, J.M., et al. "Global Trajectories of the Long-Term Decline of Coral Reef Ecosystems." *Science* 301 (2003): 955–58.
[9] National Oceanic and Atmospheric Administration. State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2002. Silver Spring, MD, 2002.
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[11] Oceana. 2003. Deep Sea Corals. Washington, DC, 2003
[12] National Oceanic and Atmospheric Administration. *A National Coral Reef Action Strategy. Report to Congress on Implementation of the Coral Reef Conservation Act of 2000 and the National Action Plan to Conserve Coral Reefs in 2002–2003*. Silver Spring, MD, June 2002.
[13] National Oceanic and Atmospheric Administration. *State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2002 Report*. Silver Spring, MD, 2002.
[14] Pandolfi, J.M., et al. "Global Trajectories of the Long-Term Decline of Coral Reef Ecosystems." *Science* 301 (2003): 955–58.
[15] Global Coral Reef Monitoring Network. *Status of Coral Reefs of the World: 2002*. Ed. C. Wilkinson. Cape Ferguson, Queensland: Australian Institute of Marine Science, 2002.
[16] National Oceanic and Atmospheric Administration. *A National Coral Reef Action Strategy. Report to Congress on Implementation of the Coral Reef Conservation Act of 2000 and the National Action Plan to Conserve Coral Reefs in 2002–2003*. Silver Spring, MD, June 2002.

Chapter 22: Setting a Course for Sustainable Marine Aquaculture

As world consumption of seafood continues to increase, the farming of marine species has become a rapidly growing domestic and international industry. There are, however, a number of challenges that this industry presents. Nearshore marine aquaculture activities are affected by increasing population and development pressures and confusing or overlapping laws, regulations, and jurisdictions. Aquaculture operations in offshore waters lack a clear regulatory regime, and questions about exclusive access have created an environment of uncertainty that is detrimental to investment in this industry. Also of concern are potential threats to the environment and to native fish populations, and conflicts between aquaculture and other uses of the nation's ocean and coastal waters. A lead federal agency with an office dedicated to marine aquaculture is needed to address jurisdictional issues and to ensure the development of an economically and environmentally sound marine aquaculture industry.

Acknowledging the Growing Significance of Marine Aquaculture

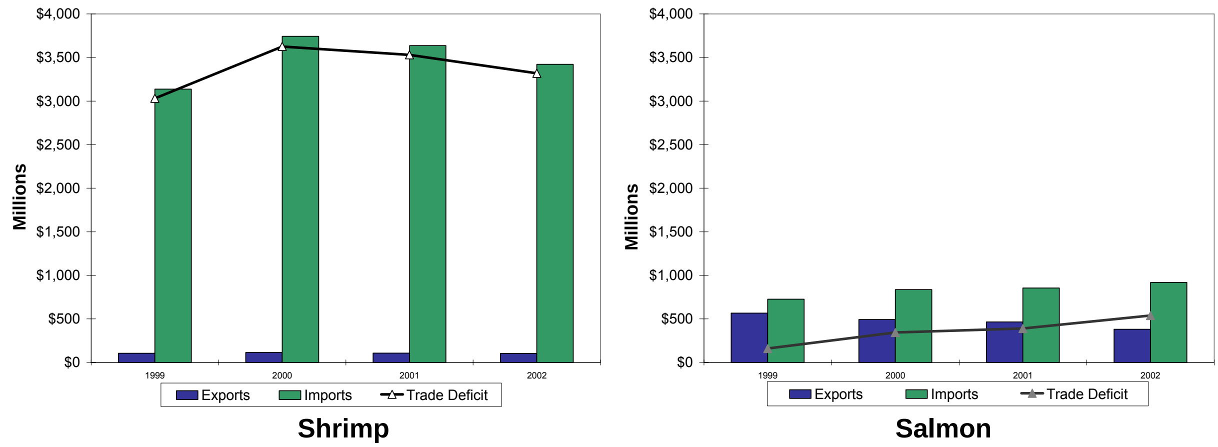
As traditional harvest fisheries have approached and exceeded sustainable levels, the farming of fish, shellfish, and aquatic plants in marine and fresh waters has become a burgeoning global industry. These animals can be raised in everything from nearly natural environments to enclosed structures, such as ponds, cages, and tanks, where they are fed and treated to maximize their growth rate.

In the United States, the demand for seafood continues to grow as expanding numbers of Americans seek healthier diets. During the 1980s and 1990s, the value of U.S. aquaculture production rose by about 400 percent, to almost $1 billion. This figure includes freshwater and marine finfish and shellfish, baitfish, and ornamental fish for sale to aquariums.[1] Along with fish farmers themselves, the aquaculture industry supports an infrastructure of feed mills, processing plants, and equipment manufacturers. There is great potential for marine aquaculture to become an even more important source of seafood for the U.S. market and a way to help reduce the nation's seafood trade deficit of $7 billion a year (Figure 22.1).[2]

Addressing Environmental Impacts of Aquaculture

National management of marine aquaculture activities should minimize potential environmental impacts. These impacts include the spread of disease among fish populations, genetic contamination and competition between farmed and native stocks, and effects from aquaculture operations on water quality, wetlands, and other natural habitats. Fish waste, dead fish, uneaten food, and the antibiotics and hormones used to promote growth in captivity may contaminate the water around aquaculture facilities and harm surrounding ecosystems. Marine mammals, attracted by the food source, can become entangled in nets. There are also concerns about the increased demand for fishmeal used to feed farm-raised carnivorous fish. Obtaining fishmeal from traditional wild harvest practices may increase the pressure on fisheries that are already fully exploited. Extensive research is underway by the aquaculture community to determine how to decrease this demand.

Figure 22.1. The United States Imports More Seafood than it Exports



The dollar values of U.S. imports and exports for both shrimp and salmon illustrate the trade deficits caused by the nation's inability to harvest or culture enough seafood to meet consumer demand. Increasing aquaculture activities could help to reduce the nation's dependence on foreign seafood.

Source: U.S. Department of Agriculture, Economic Research Service. *Aquaculture Outlook 2003*. LDP-AQS-17. Washington, DC, March 14, 2003.

Another issue of increasing concern is the possible introduction of non-native species (intentionally or unintentionally) through marine aquaculture operations. In the United States, many cultured marine species are not native to the area where they are being farmed. In these cases, there is the possibility that foreign or genetically-modified species, or their reproductive offspring, may escape and potentially compete or reproduce with wild populations, resulting in unpredictable changes to ecological, biological, and behavioral characteristics. Where non-native species come in contact with already depleted fish or shellfish stocks, recovery efforts may be hampered.

Potential problems associated with the introduction of non-native species are illustrated in the case of the Atlantic salmon, which is one of the most widely farmed fish species in the United States and around the world. Escaped farm-bred salmon, which differ genetically from species of wild Atlantic salmon, have the potential to both compete with native salmon species (at least one of which has been listed as threatened or endangered under the Endangered Species Act) for limited resources, interbreed with native species causing changes in the gene pool, and spread disease. Infectious salmon anemia and sea lice, which are widespread in European salmon aquaculture facilities, have recently appeared in North American operations.[3]

Another example, discussed in more detail in Chapter 17, is the proposed farming of a non-native oyster species from China in Chesapeake Bay tributaries. This Chinese oyster appears to be resistant to the diseases plaguing the native species. However, a 2003 National Research Council report raised serious questions about the possible ramifications of such an introduction.[4] It is now up to state officials to decide what is best for the Bay, in both the short- and long-term, with little science or law to guide them.[5] Ironically, the steep decline in the Bay's native oyster population was caused in part by a disease introduced in the 1950s during a previous attempt to establish a non-native oyster species.

DEALING WITH UNCERTAINTIES IN THE EXISTING MANAGEMENT STRUCTURE

The potential contribution of marine aquaculture to the nation's economic growth and to meeting the increasing demand for seafood is impeded by its current management framework, which is characterized by complex, inconsistent, and overlapping policy and regulatory regimes administered by numerous state and federal agencies.

Federal Involvement

Federal agencies directly or indirectly involved in regulating marine aquaculture include the U.S. Departments of Agriculture and the Interior, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers (USACE), the U.S. Coast Guard, and the U.S. Environmental Protection Agency (EPA). The responsibilities of these agencies range from protecting water quality and other environmental issues, to navigation, to food safety concerns, to interactions with federal fishery management plans. The jumble of authorities makes it difficult for those involved in aquaculture activities to know what permits are needed and to be able to comply with all of the relevant rules governing their operations.

Because nearly all marine aquaculture activities operating today are located in nearshore waters under state jurisdiction, the majority of laws and regulations that authorize, permit, or control these activities are found at the state level and are not designed to address offshore aquaculture activities in federal waters.

Marine Aquaculture in Offshore Areas

As competition for space in nearshore areas intensifies, the marine aquaculture industry is looking increasingly toward opportunities in federal offshore waters. The nation's first commercial open ocean aquaculture operation began in 2001, when ownership of a public project in Hawaiian waters was transferred to a private firm. Other offshore aquaculture activities—most of which are in the pilot project stage—include the operation of a net pen adjacent to an oil platform in the Gulf of Mexico, and federally sponsored experiments off the coasts of Massachusetts and Hawaii.

The expansion of aquaculture activities into offshore waters provides potential benefits as well as additional concerns. Locating marine aquaculture activities farther offshore may reduce the visibility of these activities from land, be less intrusive to fisheries and recreational activities, and have fewer environmental impacts than activities located in nearshore areas. However, the logistics associated with operating offshore facilities are also more difficult, requiring long transit times for workers and supplies and other technical complications. Offshore aquaculture structures must also be designed to withstand the effects of extreme winds, waves, and temperatures, and be positioned in a way that does not create a hazard to navigation.

The Current Regulatory Conundrum

The Outer Continental Shelf Lands Act confirmed federal jurisdiction over non-living resources beyond three nautical miles from shore and authorized the Secretary of the Interior to create a legal regime—including leasing rights, fees, and revenue-sharing requirements—for oil, gas, sulfur, and other mineral resources. The Act, however, does not cover other commercial activities in federal waters, such as aquaculture. The Coastal Zone Management Act grants states the right—under prescribed circumstances—to review and raise objections to federally permitted activities beyond state waters, but the Secretary of Commerce may override the state's objection. Moreover, as described above, numerous federal agencies are directly or indirectly involved in implementing laws associated with various aspects of offshore activities, including marine aquaculture.

In 1980, Congress passed the National Aquaculture Act stating that it is in the national interest to encourage the development of aquaculture in the United States and calling for a national aquaculture development plan. The Act required the Secretaries of Agriculture, Commerce, and the Interior to prepare a report on federal laws and regulations that restrict the development of commercial aquaculture operations and submit the report to Congress with recommendations on how to remove unnecessarily burdensome regulatory barriers. However, no comprehensive and streamlined regulatory regime has been developed.

This does not mean that no regulatory requirements exist for offshore aquaculture: prospective operators of an aquaculture facility on the outer Continental Shelf (OCS) can apply to USACE for a permit pursuant to Section 10 of the Rivers and Harbors Act; EPA has authority pursuant to the Clean Water Act to regulate effluent and other discharges from most aquaculture facilities on the OCS; the National Marine Fisheries Service and the U.S. Fish and Wildlife Service have authority to regulate offshore aquaculture facilities with respect to activities involving the Marine Mammal Protection Act and the Endangered Species Act; the Coast Guard has authority to require lights and signals and establish a safety zone to protect the facility and other users of the offshore waters; and coastal states may have and exercise "federal consistency" authority pursuant to the Coastal Zone Management Act.

Another potential legal impediment, which increases the legal and economic risk for offshore aquaculture, is NOAA's assertion, through an agency legal opinion, that aquaculture facilities in the exclusive economic zone are subject to the Magnuson-Stevens Fishery Conservation and Management Act if the aquaculture operation uses any harvesting or support vessel. While the Magnuson-Stevens Act may not have been intended as a vehicle for managing marine aquaculture, such assertion of authority by NOAA contributes to an already muddled management regime.

As a result of this inconsistent mix of laws and regulations, applicants have no guarantee of exclusive use of space in offshore areas, private capital is difficult to obtain, insurance companies do not provide coverage, and banks are unwilling to accept the unknown risks involved. Enhanced predictability is needed, as is the elimination of unnecessary hurdles and the reduction of potential conflicts with other commercial and recreational users of offshore areas and resources. (More information about developing a framework for managing multiple activities in federal waters, including aquaculture, is found in Chapter 6.)

Developing a New Marine Aquaculture Management Framework

For the marine aquaculture industry to reach its full potential, the United States should develop a coordinated and consistent policy, regulatory, and management framework. Federal and state agencies, with full participation by the industry, will need to implement the new framework, and the academic community will be called upon to provide scientific and engineering support to ensure that marine aquaculture activities are ecologically and economically sustainable. This framework must be flexible and responsive to changes in the industry. Finally, development of a national aquaculture management framework must be considered within the context of overall ocean policy development, taking into account other traditional, existing, and proposed uses of the nation's ocean resources.

Coordinated Action

The inherent differences between land-based, closed-system aquaculture operations and marine-based operations should be acknowledged in any new legislation and in the new management framework. The respective roles of the federal agencies involved with the marine aquaculture industry must also be clarified, duplicative or outdated laws and regulations eliminated, and marine aquaculture policies, programs, and practices coordinated. In addition, a lead federal agency is needed to act as the main interface with industry and overseer of the government's public trust responsibilities.

The National Aquaculture Act of 1980 established the Joint Subcommittee on Aquaculture (JSA) within the National Science and Technology Council (NSTC) structure. The JSA coordinates federal agency activities, ensures communication among the agencies, and provides recommendations for national aquaculture policy. Members of the JSA include: the Secretaries of the Departments of Agriculture (permanent chair), Commerce, the Interior, Energy, and Health and Human Services; the Administrators of the Environmental Protection Agency, the Small Business Administration and the U.S. Agency for International Development; the Chair of the Tennessee Valley Authority; and the Director of the National Science Foundation. This kind of coordination is very much needed, although the issues to be addressed go far beyond the purview of the NSTC. Close coordination will be needed between JSA and the National Ocean Council.

Recommendation 22–1. Congress should amend the National Aquaculture Act to designate the National Oceanic and Atmospheric Administration (NOAA) as the lead federal agency for

implementing a national policy for environmentally and economically sustainable marine aquaculture and create an Office of Sustainable Marine Aquaculture in NOAA.

Implementation

In overseeing marine aquaculture activities, including evaluating and approving offshore aquaculture operations, NOAA will need to practice wise stewardship of ocean resources and weigh the needs of a variety of stakeholders. At the same time, offshore aquaculture operators will need assurance that they can have exclusive access to certain waters for specific periods of time to secure financial investments.

These goals can best be achieved through the development and implementation of a leasing system for the water column and ocean bottom that protects marine resources and environments, offers adequate exclusivity to aquaculture operations, and institutes a system of revenue collection that acknowledge the public interest in ocean space and resources. The leasing system will also need to specify details, such as applicant eligibility and the acceptable scope, size, duration, and degree of exclusivity for facilities. Competing uses of ocean and coastal areas, and the potential for impacts from aquaculture on other ocean uses, must also be considered. A comprehensive leasing system will also reduce duplicative information collection by different agencies, and facilitate coordinated federal responses.

Enhanced coordination is also needed between federal and state aquaculture policies and regulations to provide consistency to the industry and to adequately manage potential impacts that cross jurisdictional lines, such as the spread of disease. Significant state participation and input is needed in the development and implementation of a new national management framework, which should include guidelines and regulations that are complementary at the federal and state levels.

Recommendation 22–2. The National Oceanic and Atmospheric Administration's new Office of Sustainable Marine Aquaculture should be responsible for developing a comprehensive, environmentally-sound permitting, leasing, and regulatory program for marine aquaculture.

The permitting and leasing system and implementing regulations should:

- *reflect a balance between economic and environmental objectives consistent with national and regional goals.*
- *be coordinated with guidelines and regulations developed at the state level.*
- *include a system for the assessment and collection of a reasonable portion of the resource rent generated from marine aquaculture projects that use ocean resources held in public trust.*
- *include the development of a single, multi-agency permit application for proposed marine aquaculture operations.*
- *include a permit review process that includes public notice and an opportunity for state, local and public comment.*
- *require applicants to post a bond to ensure that any later performance problems will be remedied and that abandoned facilities will be safely removed at no additional cost to the taxpayers.*
- *require the development, dissemination, and adoption by industry of best management practices that are adaptable to new research and technology advances.*
- *be well coordinated with other activities in federal waters, as described in Chapter 6.*

Increasing the Knowledge Base

Enhanced investments in research, demonstration projects, and technical assistance can speed the development of a responsible and sustainable marine aquaculture industry. Science-based information can help the industry address environmental issues, conduct risk assessments, develop technology, select species, and improve best management practices. It is also vital for developing fair and reasonable policies, regulations, and management measures.

In the last two decades, the number of research and monitoring programs related to aquaculture has surged. Much of the work conducted worldwide has focused on the effects of open-water, net-pen culture on the environment. In the United States, early research efforts focused on fish hatchery effluents and catfish ponds.

As the domestic industry has diversified, so has the scope of research efforts, with major federal investments to examine the impacts of marine shrimp-pond and salmon net-pen cultures, as well as issues concerning aquaculture feeds, species introductions, the use of chemicals and pharmaceuticals, and effluent controls.

Most of the federal research to support marine aquaculture has been carried out under the auspices of NOAA's National Sea Grant College Program, which funds primarily university-based research. Results are used by educators and outreach specialists to improve resource management and address development and conservation issues. Sea Grant-funded information is also used to increase the knowledge base of industry, government agencies, and the public.

Recommendation 22–3. Congress should increase funding for expanded marine aquaculture research, development, training, extension, and technology transfer programs in the National Oceanic and Atmospheric Administration. The Office of Sustainable Marine Aquaculture should set priorities for the research and technology programs, in close collaboration with academic, business, and other stakeholders.

Promoting International Improvements and Cooperation

An estimated one billion people worldwide rely on fish as their primary source of animal protein. This demand will continue to rise as human populations increase and wild stocks around the world are depleted. Aquaculture has been growing almost six times faster in developing countries than in developed countries. The United Nations Food and Agriculture Organization (FAO) estimates that by 2030 more than half of the fish consumed globally will be produced through aquaculture.[6]

While the majority of international aquaculture occurs in inland and coastal areas, interest in offshore operations is also growing. There are even proposals to establish aquaculture operations on the high seas (see Chapter 29 for a discussion of emerging international ocean-related management challenges). This new interest is accompanied by growing concerns about the potential environmental impacts of offshore operations. The use of non-native species for aquaculture also poses ecological risks, particularly in view of the absence of regulations and enforcement in many countries. Global policies on prevention, containment, monitoring and risk assessments are needed to prevent the spread of invasive species and ensure that industries operate sustainably.

Efforts are underway at FAO to assess the possible environmental implications of booming aquaculture operations around the world and to develop appropriate protocols for use by government and industry. In the meantime, FAO's non-binding Code of Conduct for Responsible Fisheries includes a number of aquaculture provisions. The Code calls for: appropriate assessments and monitoring to minimize adverse impacts from discharges of effluents, waste, drugs and chemicals; consultation with neighboring countries prior to the introduction of nonnative species; conservation of genetic diversity; and responsible choices of species, siting and management. These guidelines are excellent but their implementation will require much stronger national commitments.

Recommendation 22–4. The United States should work with the United Nations Food and Agriculture Organization to encourage and facilitate worldwide adherence to the aquaculture provisions of the Code of Conduct for Responsible Fisheries.

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Chapter 23: Connecting the Oceans and Human Health

While marine animals and plants are most commonly used as sources of food, they also produce a vast array of chemical compounds that can be developed into products with beneficial medical and industrial uses. However, marine organisms such as bacteria, algae, and viruses can also be sources of human illness. Although these microorganisms exist naturally in the ocean, human actions can lead to ocean conditions that greatly increase their growth, harming the health of humans, marine species, and ecosystems. Significant investment must be put into developing a coordinated national research effort to better understand the links between the oceans and human health, with research aimed at discovering new drugs and other useful products derived from marine organisms, and detecting and mitigating outbreaks of disease and other harmful conditions. Efforts must also be aimed at improving public awareness about how pollution and waste can contribute to the spread of seafood contamination and disease and can decrease the diversity of species that provide new bioproducts.

Understanding the Links between the Oceans and Human Health

While the topics generally included under the umbrella of Oceans and Human Health, such as harmful algal blooms and pharmaceutical development, may at first seem to be unrelated, they are actually inextricably linked. The health of marine ecosystems is affected by human activities such as pollution, global warming, and fishing. But in addition, human health depends on thriving ocean ecosystems. A better understanding about the many ways marine organisms affect human health, both for good by providing drugs and bioproducts, and for bad by causing human ailments, is needed.

The oceans sustain human health and well-being by providing food resources and absorbing waste from areas of human habitation. For many years the ocean's carrying capacity for meeting both these needs was assumed to be limitless. As we know today, this is not true. Scientists have reported that excessive human releases of nutrients and pollution into the ocean, and a subtle, yet measurable, rise in ocean surface temperatures are causing an increase in pathogens, primarily bacteria and viruses.[1,2] These environmental conditions can also cause certain species of microscopic algae to become concentrated in specific areas. Some of these organisms are capable of producing toxins that are released into the water and air, and become concentrated in tissues of fish and shellfish. When these toxins are ingested or inhaled by humans, they present health risks ranging from annoying to deadly.

On the other hand, thousands of new biochemicals have been discovered in marine organisms such as sponges, soft corals, mollusks, bacteria, and algae. Furthermore, scientists believe only a fraction of the organisms that live in the ocean have been documented, underscoring the vast potential of the oceans as a source of new chemicals.[3] These natural products can be developed not only as pharmaceuticals, but also as nutritional supplements, medical diagnostics, cosmetics, agricultural chemicals (pesticides and herbicides), enzymes and chemical probes for disease research, and many other applications. Based on existing pharmaceutical products, each of these classes of marine-derived bioproducts has a potential multibillion-dollar annual market value.

A 1999 National Research Council (NRC) report recommended a renewed effort to understand the health of the ocean, its effects on human health, and possible future health threats.[4] In a 2002 report, the NRC also emphasized the beneficial value of marine biodiversity to human health, noting that underexplored environments and organisms – such as deep-sea environments and marine microorganisms – provide exciting opportunities for discovery of novel chemicals.[5]

Currently two national programs exist that are designed to enhance our understanding of the ocean's role in human health. The first is a joint program between the National Institute of Environmental Health Sciences (NIEHS) and the National Science Foundation (NSF) called the Centers for Oceans and Human Health. The centers promote interdisciplinary collaborations among biomedical and ocean scientists, with the goal of improving knowledge about the impacts of the oceans on human health. The second is the National Oceanic and Atmospheric Administration's (NOAA's) Ocean and Health Initiative, which will coordinate agency activities and focus funding on ocean and health issues such as infectious diseases, harmful algal blooms, environmental indicators, climate, weather and coastal hazards, and marine biomedicine.

In addition to these broad interdisciplinary programs, several other existing programs are focused on one or more specific subtopics. For example, ECOHAB (Ecology and Oceanography of Harmful Algal Blooms), a program created by NOAA and NSF, provides a scientific framework designed to increase our understanding of the fundamental processes leading to harmful algal blooms. Other agencies, including the Centers for Disease Control (CDC), U.S. Environmental Protection Agency (EPA), and Food and Drug Administration (FDA), administer programs that address different aspects of the links between the oceans and human health.

Maximizing the Beneficial Uses of Marine-derived Bioproducts

The marine environment constitutes the greatest source of biological diversity on the planet. Representatives of every phylum are found in the world's oceans, and more than 200,000 known species of invertebrates and algae have been documented. With so many organisms competing for survival in the challenging ocean environment, it is not surprising that many organisms produce chemicals that provide some ecological advantage. Animals and plants synthesize natural biochemicals to repel predators, compete for space to grow, and locate potential mates. Scientists have shown that these chemicals can also be developed as human pharmaceuticals and used for other biomedical and industrial applications.

Despite the potential benefits, the U.S. investment in marine biotechnology is relatively small. Japan, the world leader in marine biotechnology, has spent between $900 million and $1 billion a year for the last decade and has said it intends to significantly increase this investment in the future. About 80 percent of the Japanese investment comes from industry, with the remainder from government. By contrast, U.S. public investment in marine biotechnology research and development in 1996 was around $55 million, and U.S. industry investment is estimated at approximately $100 million annually. Yet even with this limited funding, U.S. marine biotechnology efforts since 1983 have resulted in more than 170 U.S. patents, with close to 100 new compounds being patented between 1996 and 1999.[6]

Specific Applications

Pharmaceuticals

Since the 1970s, scientists have been isolating and characterizing molecules from ocean organisms that have unique chemical structures and bioactivities. In recent years, several of these compounds have undergone clinical testing in the United States as potential treatments for cancer. Progress has also been made in finding treatments for other human ailments, such as infectious diseases, multiple sclerosis, Alzheimer's, chronic pain, and arthritis (Table 23.1).

Table 23.1 Drugs from the Sea
This table highlights some of the chemicals and biological materials isolated from marine organisms that are already in use or are being developed.

Application	Original Source	Status
Pharmaceuticals		
Anti-viral drugs (herpes infections)	Sponge, *Cryptotethya crypta*	Commercially available
Anti-cancer drug (non-Hodgkin's Lymphoma)	Sponge, *Cryptotethya crypta*	Commercially available
Anti-cancer drug	Bryozoan, *Bugula neritina*	Phase II clinical trials
Anti-cancer drug (mitotic inhibitor)	Sea hare, *Dolabella auricularia*	Phase I clinical trials
Anti-cancer drug (tumor-cell DNA disruptor)	Tunicate, *Ecteinascidia turbinata*	Phase III clinical trials
Anti-cancer drug	Tunicate, *Aplidium albicans*	Advanced preclinical trials
Anti-cancer drug	Gastropod, *Elysia rubefescens*	Advanced preclinical trials
Anti-cancer drug (microtubule stabilizer)	Sponge, *Discodermia dissoluta*	Phase I clinical trials
Anti-cancer drug	Sponge, *Lissodendoryx* sp.	Advanced preclinical trials
Anti-cancer drug	Actinomycete, *Micromonospora marina*	Advanced preclinical trials
Anti-cancer drug (G2 checkpoint inhibitor)	Tunicate, *Didemnum granulatum*	In development
Anti-cancer drug	Sponge, *Jaspis* sp.	In development
Anti-inflammatory agent	Marine fungus	In development
Anti-fungal agent	Sponge, *Trachycladus*	In development
Anti-tuberculosis agent	Sea whip, *Pseudopterogorgia*	In development
Anti-HIV virus agent	Ascidian (tunicate)	In development
Anti-malarial agent	Sponge, *Cymbastela*	In development
Anti-dengue virus agent	Marine crinoid	In development
Molecular Probes		
Phosphatase inhibitor	Dinoflagellate	Commercially available
Phospholipase A_2 inhibitor	Sponge, *Luffariella variabilis*	Commercially available
Bioluminescent calcium indicator	Bioluminescent jellyfish, *Aequora victoria*	Commercially available
Reporter gene	Bioluminescent jellyfish, *Aequora victoria*	Commercially available
Medical Devices		
Orthopedic and cosmetic surgical implants	Coral, mollusc, echinoderm skeletons	Commercially available
Diagnostics		
Detection of endotoxins (LPS)	Horseshoe crab	Commercially available
Enzymes		
Polymerase chain-reaction enzyme	Deep-sea hydrothermal vent bacterium	Commercially available
Nutritional Supplements		
Polyunsaturated fatty acids used in food additives	Microalgae	Commercially available
Pigments		
Conjugated antibodies used in basic research and diagnostics	Red algae	Commercially available
Cosmetic Additives		
Cosmetic (anti-inflammatory)	Caribbean gorgonian, *Pseudopterogorgia elisabethae*	Commercially available

Source data combined from:
Pomponi, Shirley A. “The bioprocess-technological potential of the sea.” *J. Biotechnology*, 70 (1999): 5-13.
Pomponi, Shirley A. “The oceans and human health: the discovery and development of marine-derived drugs.” *Oceanography*, 14 (2001): 78-87.
Dr. David J. Newman, NIH, National Cancer Institute, Natural Products Branch, Frederick, MD.
Jordan, M.J. and Leslie Wilson. “Mining the Ocean’s Pharmacological Riches: A Lesson from Taxol and Vinca Alkaloids.” In *Marine Biotechnology in the 21st Century*. Washington, DC: National Academy Press, 2001.

Molecular Probes

Several marine-derived compounds, explored initially as potential pharmaceuticals, are available commercially as molecular probes. These probes are special chemical compounds that researchers can use to study important biochemical processes. Their value in resolving the complexities of diseases has often outweighed their economic and medicinal value as commercial pharmaceuticals. Moreover, molecular probes often offer attractive opportunities for commercialization, with revenues generated in a shorter time than pharmaceuticals because lengthy regulatory approvals are not required for research that does not involve human subjects.

Nutrients

Marine-derived nutritional supplements, or "nutraceuticals," present a relatively new opportunity for research and development in the application of natural marine products to human health issues. Nutritional supplements from plants have been used for years, including commonly known products such as St. John's wort, ginseng, and echinacea. A few products from marine sources are also commercially available such as xanthophylls from algae, which are used in nutritional supplements and vitamins for their antioxidant properties. Although the use of marine natural products in nutritional supplements is limited at this time, it represents a large potential market.

Special Focus on Microbial Diversity

Microorganisms comprise a larger biomass than any other form of life on Earth. In addition, they are the most diverse group of organisms on the planet, having evolved to be able to survive in almost all environments. In the ocean they are the basis for food webs, even in areas that would not normally be capable of sustaining life.

For example, in the deep ocean environment with no light and few nutrients, chemosynthetic bacteria thrive on the methane present in frozen gas hydrates. Near deep-sea hydrothermal vents where temperatures can rise to over 300 degrees Celsius, bacteria are capable of using hydrogen sulfide and carbon dioxide as their only nutrients and producing enough organic compounds to support whole vent communities, including tubeworms, fish, crabs, shrimp, clams, and anemones.

However, microorganisms have not evolved simply to synthesize molecules for food; they have also been shown to produce a wide array of chemicals for other purposes. Understanding how these organisms survive, both individually and symbiotically, and why they produce such unique chemistry is essential to understanding their therapeutic and technological potential. Yet, only a small percentage of these organisms have been documented, largely due to difficulties in culturing organisms from such unique habitats. An expanded search for new microbes in the ocean based on cooperation among a number of multidisciplinary government programs could yield exciting results.

Industrial Uses

In additional to medicinal uses, chemicals produced by marine organisms have a wide array of industrial applications. For example, marine organisms, such as limpets, produce adhesive proteins that hold them strongly to surfaces against the pull of tides and waves. Currently, researchers are examining the chemistry of these adhesives to produce new glues that work in wet environments. Some cold water marine microorganisms are being studied because of chemicals they produce that can be used as detergents. These chemicals could help produce commercial detergents that are more effective in cold water. Many sedentary marine organisms produce anti-fouling chemicals that prevent algae and bacteria from clinging to their surfaces. Researchers are investigating these chemicals as potential paint additives for ship hulls. If effective, these chemicals could reduce the need for traditional anti-fouling paints that contain high levels of tin and other heavy metals, which can contaminate bottom sediments. Several other applications of marine-derived substances are currently in development, such as reaction enzyme catalysts and biochemicals used for detoxifying chlorinated hydrocarbons and other pollutants.

Encouraging Interdisciplinary Marine Biomedical Research

Past U.S. efforts to discover marine biomedicines were of the collect-and-test type, with little attention given to the evolutionary, environmental, and molecular biology of the species being tested. However, to realize the greatest rewards for research investments, each species' ecological, genetic, and physiological information should be examined to understand how they adapt to environmental conditions. The unique diversity and adaptations of marine life can help scientists understand the evolutionary development of biochemical signals that regulate cell cycles and control resistance against diseases and infections.

Historically, structural limitations inherent in the federal agencies made it difficult to undertake truly multidisciplinary science. NSF restricted funding for biomedical research because it is covered by the National Institutes of Health (NIH), creating difficulties in establishing combined environmental and biomedical research programs. Likewise, NIH has generally supported direct medical research, thus precluding ancillary studies of systematics, ecology, and species distributions. Until a few years ago, the NIH's ocean pharmaceutical programs had been very narrow, focusing almost exclusively on discovering and developing new anti-cancer drugs. Thus, the very structure of the federal scientific support system has been counterproductive to establishing the type of multidisciplinary programs required to advance the broader field of marine natural product discovery and development.

Based on recommendation from the National Research Council and others, in the last two years new approaches for supporting marine bioproduct development have been established that allow the necessary cross-disciplinary research to occur, including the NIEHS–NSF and NOAA programs mentioned earlier. However, increased participation and cooperation from other federal agencies, including EPA, the Office of Naval Research (ONR), the National Aeronautics and Space Administration (NASA), CDC, FDA, and the Minerals Management Service (MMS), each of which brings particular expertise and perspectives, will also be helpful.

Recommendation 23–1. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support expanded research and development efforts to encourage multidisciplinary studies of the evolution, ecology, chemistry, and molecular biology of marine species, discover potential marine bioproducts, and develop practical compounds, through both competitively awarded grants and support of federally designated centers.

These efforts should include:

- *a strong focus on discovering new marine microorganisms, visiting poorly sampled areas of the marine environment, and studying species that inhabit harsh environments.*
- *encouragement for private-sector investments and partnerships in marine biotechnology research and development to speed the creation of commercially available marine bioproducts.*

Managing Marine Bioproduct Discovery and Development

Based on the potentially large health benefits to society, the federal government should encourage and support the search for new bioproducts from marine organisms, known as bioprospecting. However, before wide-scale bioprospecting proceeds in federal waters, requirements need to be established to minimize environmental impacts. Planning and oversight will help ensure that public resources are not exploited solely for private gain and will help protect resources for future generations.

Individual states can regulate the collection of marine organisms quite differently, sometimes requiring an array of research permits to collect organisms, and licenses to gain access to particular areas. Regulations that ban the removal of specific organisms, such as corals and other sensitive species, often exist in both state and federal protected areas. In protected federal waters, such as national marine sanctuaries, research permits are required for all collections. However, bioprospecting outside state waters and federal protected areas is unrestricted, except for certain species subject to regulation under existing legislation, such as the Endangered Species Act. Both U.S. and foreign researchers, academic and commercial, are free to collect a wide range of living marine organisms without purchasing a permit and without sharing any profits from resulting products.

On land, the National Park Service has successfully asserted the government's right to enter into benefit sharing agreements in connection with substances harvested for commercial purposes in Yellowstone National Park. The National Park Service is in the process of conducting a full environmental impact statement on the use of such agreements for benefit sharing in other parks. This practice could serve as a model for the management of bioprospecting in U.S. waters.

A comprehensive national ocean policy should contain appropriate permitting and licensing regulations for bioprospecting in federal waters to protect public resources while encouraging future research. Furthermore, when allocating use of federal ocean areas for bioprospecting, it is important that consideration be given to the other potential uses of those areas, including oil and gas exploration, renewable energy, aquaculture, or mining. (The governance and coordination of offshore uses is discussed in detail in Chapter 6.)

Reducing the Negative Health Impacts of Marine Microorganisms

A host of microorganisms exist in marine waters, filling their roles in the ecosystem and generally causing no problems to humans. However, environmental factors such as climate change can affect the number and distribution of marine pathogens and human activities can produce even greater fluctuations that threaten the human health and the marine ecosystems they depend on for food, medicine, and other products.

Harmful Algal Blooms

The term harmful algal bloom (HAB) is used to describe destructive concentrations of particular algal species in ocean waters. These blooms are sometimes called red tides because the high algal density can make the ocean surface appear red, but the surface may also be green, yellow, or brown, depending on the type of algae present.

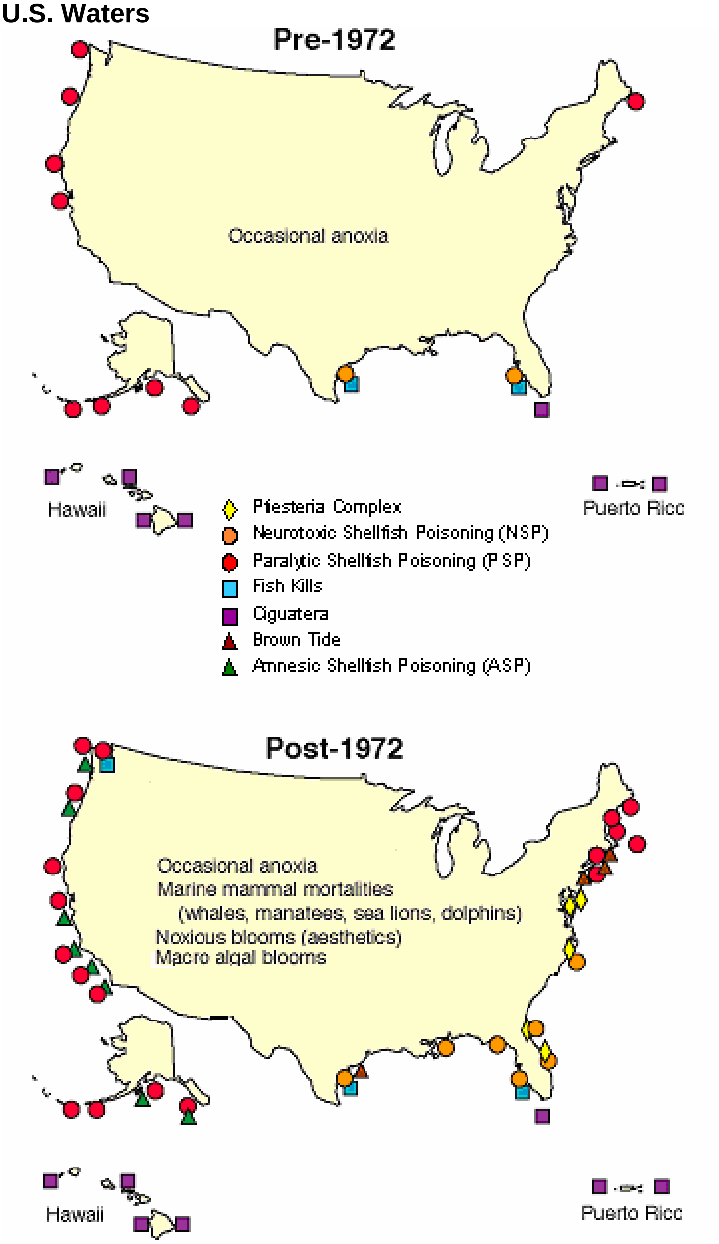
The Nature of the Problem

The underlying physical, chemical, and biological causes for most harmful algal blooms are not well understood, but an increase in distribution, incidence, duration, and severity of HABs has been documented within recent decades (Figure 23.2). Research is needed to understand why blooms form in a specific area, how they are transported, and what causes them to persist. In many areas, increases in nutrients in coastal waters, from point and nonpoint sources of pollution, and higher numbers of invasive species released from ships' ballast water mirror the increase in HAB events, suggesting a possible causal connection.[7, 8] However, others have suggested that the apparent increase in HAB events is simply a result of more frequent and effective monitoring.

HABs can produce high concentrations of potent toxins in ocean waters. When these toxins are concentrated in fish and other seafood consumed by humans, they can lead to paralytic, diarrhetic, neurotoxic, or amnesic shellfish poisoning. Most of these toxins cause harm only if ingested; however, some enter the air from sea spray and can cause mild to severe respiratory illnesses when inhaled. These health effects are not restricted to human populations; fish, birds, and marine mammals often fall victim to red tide poisoning.

Annually, HABs are believed to cost the nation's fishing and tourism industries more than $50 million directly, with a likely multiplier effect that pushes the total economic loss to $100 million.[9, 10] This effect can be catastrophic to low-income fishing communities, as witnessed in Maryland in 1997 during an outbreak of *Pfiesteria piscicida* (a species of dinoflagellate) associated with widespread fish kills.[11] Tourism was hurt by news coverage of seafood poisonings, and reports of red tides had a swift and chilling effect on oceanside resort visits, beach-going, and boating. Aquaculture can also be severely damaged by HABs, which can cause rapid fish kills and result in harvesting moratoria.

Figure 23.2 Harmful Algal Blooms Are on the Rise in All U.S. Waters



Harmful Algal Bloom outbreaks have become more prevalent over the past thirty years, almost tripling the number detected prior to 1972.

Map courtesy of the National Office for Marine Biotoxins and Harmful Algal Blooms, Woods Hole Oceanographic Institution, Woods Hole, MA.

HABs are of particular concern in areas where the water contains high concentrations of dissolved nutrients. These areas are incubators for many types of algal blooms, nontoxic as well as toxic. The nutrients create conditions for rapid growth of large and dense algal blooms. When the algae die, their decomposition consumes the dissolved oxygen that other organisms need for survival.

Improving Understanding, Detection, and Prevention

HABs constitute significant threats to the ecology and economy of coastal areas. While the preferred course of action is prevention, effective treatments will often be needed and the current availability of biological, chemical, or physical treatments is extremely limited. The ecology of each bloom is different, and the required environmental conditions are not completely understood for any algal species.

The most likely and immediate solution for reducing the number and severity of HABs is to control nutrient inputs to coastal waters. (Nutrient pollution is further discussed in Chapter 14.) Prevention may also be strengthened through careful facility siting decisions and tighter controls on invasive species. However, for better long-term management, a comprehensive investigation of the biology and ecology of HABs will be needed to increase our understanding of options for prevention, prediction, and control.

Better coordination would help leverage the relatively few but successful HAB research programs currently being supported by the federal government (such as ECOHAB; MERHAB—monitoring and event response for harmful algal blooms; NOAA's National Marine Biotoxin program and HAB sensor development and forecasting programs; and efforts supported by the CDC, states, and others).

Improved monitoring techniques are also essential in mitigating the harmful impacts of HABs. Sampling directly from the natural environment can help researchers compile an overall HAB picture, laying the foundation for predictive modeling and forecasting. Numerous monitoring programs already exist, many of which are funded by state governments. However, routine field sampling, combined with laboratory analysis, is expensive and time consuming, and becomes more so as greater numbers of toxins and pathogens are discovered over greater geographic areas. A well-coordinated federal effort is needed to support the state and regional implementation of monitoring and mitigation capabilities as they are developed. (See Chapter 15 for a broader discussion of water quality monitoring needs.)

To cover larger areas, monitoring data collected from remote sensing platforms will become essential. NOAA is currently developing and testing techniques to forecast HAB occurrence and movement using satellite sensors. The complementary development and deployment of satellites and moored sensors will provide even greater coverage, cross-referenced groundtruthing, and more frequent site-specific sampling. These elements will add up to better data sets for monitoring of HABs. As more data is collected on HAB occurrences, researchers will be able to more accurately predict future outbreaks by using advanced computer models and taking into account the physical and biological conditions leading to HABs.

Marine Bacteria and Viruses

Bacteria and viruses are present everywhere in the ocean; in fact, each milliliter of seawater contains on average 1 million bacteria and 10 million viruses. While only a small percentage of these organisms cause disease in humans, they pose a significant health risk. Humans become exposed to harmful bacteria and viruses primarily by eating contaminated seafood (especially raw seafood) and by direct intake of seawater.

Many, if not most, occurrences of high concentrations of pathogens in the ocean are the direct result of land-based human activities. Pollution and urban runoff lead to nutrient-rich coastal and ocean waters that provide ideal conditions for the growth and reproduction of these microorganisms. With ever-increasing numbers of people living in coastal areas, along coastal watersheds, or inland along rivers that ultimately drain into the ocean, waste and pollution has increased to a level that creates negative environmental and human health-related consequences.

A comprehensive and integrated research effort is needed to further explore the relationship between human releases of inorganic and organic nutrients to coastal waters and the growth of pathogenic microorganisms in the ocean. Rapid monitoring and identification methods need to be developed so officials can warn populations at risk when unhealthy conditions are present. Integration of these new methods into moored biological sensors and the Integrated Ocean Observing System (IOOS) would allow for continuous data collection, and be especially helpful in areas of high recreational or seafood harvesting activity. This effort must include the participation of state, regional, tribal, and local organizations to implement localized monitoring programs and address public education issues associated with marine bacteria and viruses.

Contaminated Seafood

Contaminated seafood is one of the most frequent causes of human diseases contracted from the ocean, including both pathogenic contamination and chemical contamination. Chemicals such as mercury and dioxins, that exist as environmental contaminants and are concentrated in fish through bioaccumulation, continue to be a health concern for humans, especially in terms of reproductive and developmental problems. In addition, harmful algal blooms and pathogen outbreaks are becoming more common in local waters, increasing the risk of seafood contamination.

Aside from domestic sources, Americans are importing more seafood than ever before.[12] These imports often come from countries whose public health and food handling standards are lower than in the United States. Although the Food and Drug Administration requires that importers to the United States meet federal standards, there is evidence that foreign counties do not always comply with these agreements, increasing the risk of spreading disease through improperly processed and handled seafood.[13] Federal law also bars seafood containing drugs from entering the country, but the FDA currently only screens about 2 percent of the four billion pounds of seafood imported each year, and screens for only five chemicals out of the more than thirty used in foreign aquaculture. While other countries have barred salmon shipments that test positive for such drugs as malachite green (a fungicide) and oxytetracycline (an antibiotic), the United States does not currently test salmon imports for these chemicals.[14]

Domestic aquaculture may provide a way to decrease U.S. dependence on imported seafood. However, cultured organisms are generally exposed to more diseases than wild stocks due to over-crowding in the fish pens. The use of antibiotics and other drugs to protect farmed fish against disease is a problem that will also need to be addressed in the United States. (The potential and problems of aquaculture are discussed further in Chapter 22.)

To protect the safety of the nation's seafood, rapid, accurate, and cost-effective means for detecting pathogens and toxins in seafood are needed. As these techniques are developed they can be incorporated into seafood safety surveillance efforts, particularly inspections of imported seafood and aquaculture products.

Implications of Global Climate Change

In addition to the direct effects of human activities, marine microorganisms' survival and persistence are also strongly affected by environmental factors. In particular, global climate change has the potential to significantly alter the distribution of microorganisms in the ocean. Pathogens now limited to tropical waters could move toward the poles as sea-surface temperatures rise.

For example, the bacterium that causes cholera (*Vibrio cholerae*) has been implicated in disease outbreaks fueled by the warming of coastal surface water temperatures. The intrusion of these warmer, infected waters into rivers can eventually lead to mixing with waters used for drinking and public hygiene. An indirect relationship has also been noted between climate change phenomena associated with the Bay of Bengal and the incidence of cholera in Bangladesh. As the temperature in the Bay of Bengal increased, plankton growth accelerated, which in turn created ideal growth conditions for bacteria such as *Vibrio cholerae*.[15]

Mass mortalities due to disease outbreaks have already affected major life forms in the ocean. The frequency of epidemics and the number of new diseases in corals and marine mammals have increased. It is hypothesized that some of these outbreaks are linked to climate change. Not only are new pathogens possibly present due to changes in water temperature, but temperature changes can also stress marine organisms, making it harder for them to fight infections.[16] More research is needed to understand the links among climate change, pollution, marine pathogens and the mechanisms of disease resistance in marine organisms.

Progress through Research and Education

Research Needs

Better understanding about the links between oceans and human health will require a commitment of research funds to discover the fundamental processes controlling the spread and impacts of marine microorganisms and viruses. In addition, closer collaboration between academic and private sector scientists and federal agencies (including NIH, NSF, NOAA, EPA, ONR, NASA, CDC, FDA, and MMS) will be needed to better examine these issues.

Recommendation 23–2. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support expanded research efforts in marine microbiology and virology.

These efforts should include:

- *the discovery, documentation, and description of new marine bacteria, algae, and viruses and the determination of their potential negative effects on the health of humans and marine organisms.*
- *the elucidation of the complex inter-relations, pathways, and causal effects of marine pollution, harmful algal blooms, ecosystem degradation and alteration, emerging marine diseases, and climate change in disease events.*

New knowledge and technologies are needed to detect and mitigate microbial pathogens. These methods must be quick and accurate so that information can be communicated to resource managers and the coastal community in a timely manner. As they are developed, technologies need to be integrated into biological and biochemical sensors that can continuously monitor high-risk sites. It is important that site-specific sensor data and satellite sensor data be incorporated into the IOOS. (The development of chemical and biological sensors and their integration into the IOOS is further discussed in Chapters 26 and 27.) Furthermore, federal and private support will be needed for developing monitoring and mitigation technologies to be implemented at the state level.

Recommendation 23–3. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support the development and implementation of improved methods for monitoring and identifying pathogens and chemical toxins in ocean waters and organisms.

This should include:

- *developing accurate and cost-effective methods for detecting pathogens, contaminants, and toxins in seafood for use by both state and federal inspectors.*
- *monitoring and assessing pollution inputs, ecosystem health, and human health impacts.*
- *developing new tools for measuring human and environmental health indicators in the marine environment.*
- *developing models and strategies for predicting and mitigating pollutant loadings, harmful algal blooms, and infectious disease potential in the marine environment.*
- *developing* in situ *and space-based sensing methods and incorporating them as a sustained operational component of the national Integrated Ocean Observing System.*

Public Education and Outreach

Pollution education campaigns have generally focused on the impacts of pollution on marine animals. Signs stenciled on storm drains remind people that dolphins live downstream. However, additional attention should be given to the fact that human food supplies and recreational areas are also downstream. Reductions in pollution from urban area runoff, sewage outflows, agricultural pesticides, and many other sources are needed to avoid creating harmful conditions in the oceans and the best way to start is with a higher level of public education.

Education campaigns should also continue to inform people of the potential risks some fish and shellfish pose to their health because of the bacteria, viruses, or chemicals they carry. These programs should incorporate messages that seafood may be contaminated even when no visible algal bloom is present and conversely that some unattractive algal blooms are not harmful.

INCREASING FEDERAL COORDINATION ON OCEANS AND HUMAN HEALTH

Several existing programs, including the NIEHS–NSF and NOAA programs, could form the nucleus of a fully integrated, national oceans and human health program. Most of these programs already involve significant interagency cooperation, which is essential for effectively addressing issues that cross federal agencies' jurisdictional lines and for coordinating multidisciplinary biomedical research. Any truly national effort to address the varied roles of the oceans in human health will cross many federal jurisdictions, including environmental regulation, coastal management, basic and applied research, biosecurity, and homeland security.

Recommendation 23–4. Congress should establish and fund a national, multi-agency Oceans and Human Health Initiative to coordinate, direct, and fund research and monitoring programs.

The National Ocean Council should oversee the interagency Oceans and Human Health Initiative, and should review existing interagency programs and suggest areas where coordination could be improved. The NOAA Ocean and Health Initiative should be coordinated with the NIEHS–NSF Centers for Oceans and Human Health program as the basis of the federal program and should be permanently funded. To achieve the goals set forth in this chapter, funding should be double the current combined funding level for the NIEHS-NSF Centers for Ocean and Human Health program and the NOAA Ocean and Health Initiative, resulting in total funding of at least $28 million a year for the new initiative.

NOAA should be the lead agency in charge of coordinating interagency public information, outreach, and risk assessment efforts. Research funding awarded through the national program should be subject to a stringent peer review process with federal, state, academic, and private-sector investigators eligible to compete for funding.

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Chapter 24:

MANAGING OFFSHORE ENERGY AND OTHER MINERAL RESOURCES

Chapter 6 addressed the complexities associated with developing a coordinated offshore management regime and recommended one that is among other characteristics: comprehensive, transparent, and predictable; brings a fair return to the public; and promotes a balance between economic and environmental considerations. Activities related to the management of nonliving resources in federal waters are inextricably linked to many of the fundamental policy questions raised by that discussion. From the politically contentious but administratively mature outer Continental Shelf (OCS) oil and gas program to the new and emerging offshore uses that lack coordinated and comprehensive regimes, much can be learned. But much still needs to be understood about what it may take to develop a system that unlocks the treasures of the sea while protecting the marine environment and providing all affected parties a voice in the decisions that manage that process.

Exercising Jurisdiction over Nonliving Resources in Federal Waters

In addition to its responsibilities for living marine resources, the federal government also exercises jurisdiction over nonliving resources, energy and other minerals located in the waters and seabed of the more than 1.7 billion acres of the outer Continental Shelf (OCS). Offshore oil and gas development has the most mature and broadest management structure of all such resources. It also has the longest and richest history, one characterized by major changes to the underlying law that established the more comprehensive administrative regime, as well as intense political conflict resulting from divisions among stakeholders and tensions inherent in American federalism. The development of other ocean energy resources—some of which are newly emerging technologies—have differing levels of management, but none are currently making any noteworthy contributions to domestic production numbers. Historically, there also have been varying expressions of commercial interest in non-energy minerals in the U.S. exclusive economic zone (EEZ), but only sand and gravel have been used in recent years by coastal states and communities, because of a change which eased access to those resources.

Managing Offshore Oil and Gas Resources

As noted in Chapter 2, from its beginning the federal offshore oil and gas program faced controversy over ownership issues, as states unsuccessfully sued the federal government over control of offshore waters. Once that issue was settled legislatively, there was a short but relatively stress-free period. Conflict, however, soon emerged over issues of management, environmental risks, and the costs and benefits of energy exploration and production on the OCS that continues to this day. Proponents point to the program's contributions to the nation's energy supplies and economy, significant improvements in its safety and environmental record, and noteworthy technological achievements. Opponents argue that offshore oil activities harm coastal communities economically and the marine environment unacceptably. The ongoing debate is carried out in the halls of Congress, federal agencies, state and local governments, trade associations, and nongovernmental organizations. OCS oil and gas development is a classic example of the politics of multiple use resource management, including federal-state tensions, competing user issues, arguments over the interpretation of data, and disagreements concerning tolerable levels of risk.

Despite its political problems, which are best understood through an awareness of the historical context associated with it, today the OCS oil and gas program has a well institutionalized and reasonably comprehensive management regime. While not without its critics, the program seeks to balance the many competing interests involved in offshore energy activity, requires state and local government input in federal decisions, and specifies detailed procedures to be followed by those seeking offshore leases. It also manages the various processes associated with access to non-energy minerals on the OCS.

Energy development in federal waters is big business and has become an important part of the fabric of the U.S. ocean policy mix. Most observers agree that the federal OCS oil and gas program benefits America by helping to meet energy needs, creating thousands of jobs, and contributing billions of dollars to the U.S. Treasury. Despite the limited offshore geographic area from which production flows and in which leasing is authorized, the amount of oil and gas production from the OCS is significant. In 2002 and 2003, federal offshore waters produced more than 600 million barrels of oil annually[1] and about 4.5 trillion cubic feet of natural gas.[2]

From a Quiet Beginning to Prohibitions on Leasing

In 1953, Congress enacted the Submerged Lands Act, which codified coastal states' jurisdiction off their shores out to three nautical miles (or, for historic reasons, nine nautical miles for Texas and the Gulf coast of Florida). That same year, regulation of OCS oil and gas activity seaward of state submerged lands was vested in the Secretary of the Interior with the passage of the Outer Continental Shelf Lands Act (OCSLA), which established federal jurisdiction over the OCS for the purpose of mineral leasing. For a period of some fifteen years, the offshore energy program was relatively quiet, being confined largely to leasing off of Louisiana and Texas. In the late sixties, however, the relative peace on the OCS would be dramatically changed.

As discussed in Chapter 2, the 1969 Santa Barbara blowout took place during an era of rapidly expanding environmental awareness and helped spur the enactment of numerous major environmental laws, including the National Environmental Policy Act (NEPA), the Coastal Zone Management Act (CZMA), the Marine Mammal Protection Act (MMPA), and the Marine Protection, Research, and Sanctuaries Act (MPRSA).

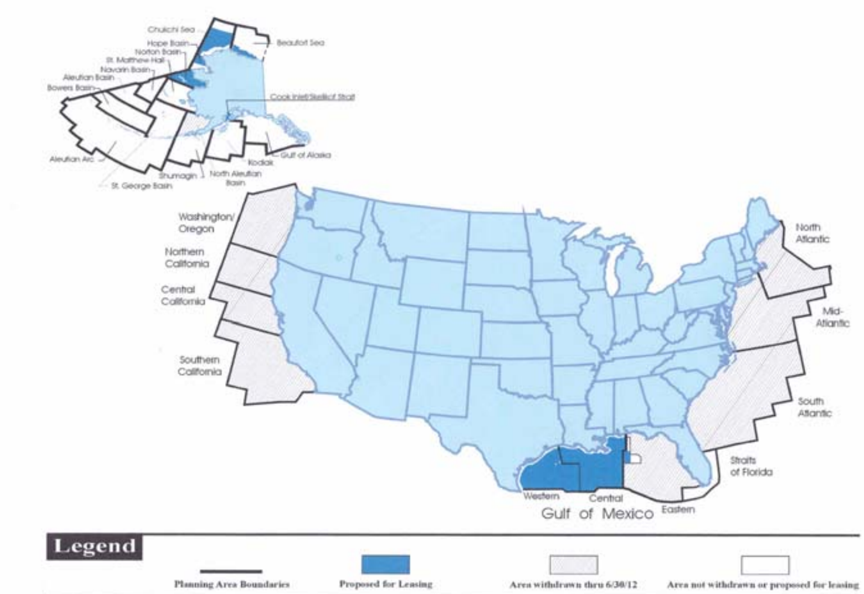
Just as the nation's environmental consciousness rose, so too did recognition of the need for secure supplies of oil and gas. Also, as noted in Chapter 2, the 1973 Arab oil embargo prompted President Nixon to announce plans to lease ten million OCS acres in 1975, an area equal to the entire amount leased prior to that time. Sales were scheduled not only in areas of earlier OCS activity, but also along the Atlantic and Pacific coasts. The result was a nationwide debate that raged through the remainder of the decade, pitting the oil and gas industry and its allies against various representatives of coastal states, commercial and sport fishing interests, and environmental organizations.

Congress responded to this debate by virtually rewriting the OCSLA in 1978, requiring the Secretary of the Interior to balance the nation's needs for energy with the protection of human, marine, and coastal environments, make certain that the concerns of coastal states and competing users were taken into account, and ensure that some of the newly enacted environmental laws were integrated into the OCS process. However, before regulations and procedures could be fully developed to support the amended law, in the early 1980s the Reagan administration proposed to terminate funding for the Coastal Zone Management Act (CZMA) and its Coastal Energy Impact Program(CEIP). The CEIP was specifically designed during the debate over the OCSLA amendments to provide grants and loans to coastal states to deal with the environmental effects occasioned by OCS activities. At the same time these budget cuts were put forward, the Secretary of the Interior was pursuing an aggressive offshore program that would make one billion acres available for oil and gas leasing over the ensuing five years. Thus began the modern day version of the battle over offshore oil, one that has endured for over two decades and has included major legislative and executive branch negotiations, actions to restrict leasing in so-called "frontier" areas, Supreme Court cases, federal-state battles over administrative procedures and the sharing of revenues, and the buyback of some OCS leases by the federal government.

In its initial reaction to the proposed budget cuts, Congress was able to save the CZMA, but not the CEIP. It then turned its attention to restricting and ultimately prohibiting a substantial part of the OCS leasing schedule of the U.S. Department of the Interior (DOI). Using its appropriations process in 1982, Congress put four basins offshore northern California off limits to leasing. For the next few years, every annual DOI funding bill included leasing prohibitions on additional regions until practically all offshore planning areas outside of the Gulf of Mexico and Alaska were excluded.

Additionally, Presidents have expanded on congressional action, providing longer term restrictions than those covered in annual appropriations bills. In 1990, President Bush withdrew areas offshore California, southern Florida, the North Atlantic states, Washington, and Oregon from leasing consideration until after 2000. A few years later, the Clinton Administration added additional areas to the restricted list, extended all of the withdrawals until 2012, and included a permanent prohibition on leasing in national marine sanctuaries. These presidential and congressional actions have removed some 610 million acres from leasing consideration and effectively limited access to the OCS program to the central and western Gulf of Mexico (95 percent of offshore production), a small portion of the eastern Gulf, and virtually all areas off Alaska (Figure 24.1).

Figure 24.1. Offshore Oil and Gas Leasing has been Limited to a Few Planning Areas



Shown above are the outer Continental Shelf planning areas in the Minerals Management Service's 2002-2007 leasing program. The entire West Coast and almost all of the East Coast have been restricted from leasing through 2012, leaving only areas of the central and western Gulf of Mexico (and a small area of the eastern Gulf) and virtually all areas off the Alaskan coast available for development.

Figure Courtesy of Minerals Management Service, Department of the Interior, Washington, DC.

The OCS Leasing, Exploration, and Development Process

As already noted, the OCSLA is a relatively comprehensive resource management statute. Besides authorizing the Secretary of the Interior to hold competitive lease sales for offshore tracts, regulate and oversee lease activities, and encourage efficient, safe, and diligent production, the law specifies the steps potential lessees must take to bid on offshore tracts and the process that occurs after receiving a lease. For example, the OCSLA requires consultation with coastal states and localities at a number of points in the federal offshore decision-making process, including during the development of a five-year leasing program, individual lease sale delineations, exploration and development-production plans, and environmental studies and oil and gas information programs. Further, the law carries provisions on offshore safety regulations, citizen suits and judicial review, enforcement authority, the applicability of NEPA, geological and geophysical exploration, export limitations, documentation requirements for offshore vessels and rigs, and numerous opportunities to address other environmental issues.

DOI's Minerals Management Service (MMS) characterizes its administration of the OCSLA as being "process rich" (Figure 24.2). Through the initial years of promulgating regulations to implement the 1978 amendments, and through litigation about the meaning of certain provisions, the current OCS leasing and development program is one that is, on balance, coherent and reasonably predictable. Although the comprehensiveness of the program has not precluded the political battles noted above nor avoided restrictions on leasing in frontier areas, in those areas of the nation where offshore development is accepted, the internal administrative process is well known and understood by those who invest in offshore leases and those who choose to observe and comment on such activity. The OCSLA is replete with references to the applicability of other statutes and the authority of other departments in the oil and gas process, and presents a clearer roadmap than most other offshore resource management laws or programs.

After an initial bumpy start in the implementation of major amendments to its basic law, the problems encountered by the offshore oil and gas program today are generally external to its day-to-day administration and regulatory requirements. Although a number of different variables have to be taken into consideration in crafting a regime for other ocean uses, the scope and comprehensiveness of the OCS oil and gas program can be a model for the management of a wide variety of offshore activities.

Trends in Domestic Offshore Oil and Gas Production

Currently, energy development in federal waters accounts for more than 30 percent of domestic oil production and 25 percent of natural gas. Further, the offshore areas of the United States contain an estimated 60 percent of the oil and natural gas yet to be discovered domestically.[3]

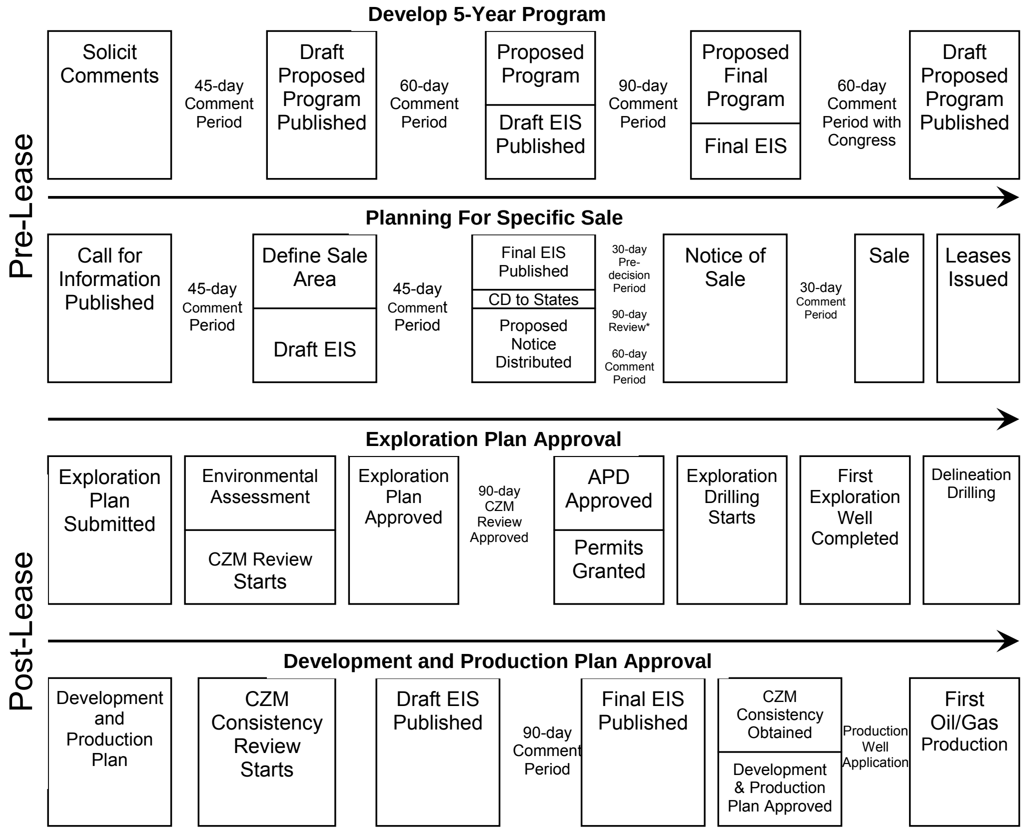
Virtually all (more than 95 percent) of U.S. offshore oil and gas production takes place in the western and central Gulf of Mexico, where there is an established infrastructure and general public acceptability. There is still some offshore production in Southern California and limited leasing and exploration in federal waters off Alaska. The first oil production from a joint federal-state lease in the Beaufort Sea (Alaska) commenced in 2001.

The importance of offshore oil and natural gas to the nation's total energy portfolio is expected to increase. The U.S. Energy Information Administration projects the United States will need about 35–40 percent more natural gas and about 45 percent more oil by 2025 to meet demand, even as new energy conservation measures are mandated and efforts to develop alternative power sources continue.[4] Government and industry experts are concerned that rising demand for and limited supplies of natural gas will continue to boost heating and electricity costs, affecting homeowners and a range of major industries. Nearly all U.S. electric-generating plants built since 1998 are fueled by natural gas.

Rise in Deep-water Oil Production

Although production in the Gulf's heavily leased shallow waters has been steadily declining, production in the Gulf's deeper waters (more than 1,000 feet), which tend to produce more oil than natural gas, increased by 276 percent between 1996 and 2000.[5] In part, this growth was attributable to technological breakthroughs, the

Figure 24.2. A "Process Rich" but Clear Path to Offshore Leasing, Exploration, and Development Activities



Abbreviations:
- APD: Application for Permit to Drill
- CD: Consistency Determination
- CZM: Coastal Zone Management
- EIS: Environmental Impact Statement

* Includes 60-day Comment Period and 15-day automatic extension. Unless State concurs, no decision can be made until 90 days after beginning of State review.

The process by which companies and other stakeholders comment on proposed sales and lease, explore, and develop the outer Continental Shelf is clearly defined in the Outer Continental Shelf Lands Act. Although there are many steps involved, its comprehensiveness and transparency not only set out clear comment periods for coastal states and other interested stakeholders, but also provide companies greater predictability about the procedures they must follow to receive approval for their exploration and production work.
Figure Courtesy of Minerals Management Service, Department of the Interior, Washington, DC

relative stabilization of crude oil prices, and the enactment of legislation in 1995 granting various levels of royalty relief to lessees willing to make the risky investment in the Gulf's deeper waters. Deep-water oil production now accounts for more than half of the Gulf's total production.[6] Additionally, the technology for ultra–deep-water development continues to advance with the drilling of a number of exploratory and production wells in water depths greater than 7,000 feet. Recently, a world record exploratory well was drilled in 10,000 feet of water.

A Promising Future for Natural Gas from Shallow Water

MMS estimates there is up to 55 trillion cubic feet (tcf) of natural gas available for production in the deep shelf areas of the Gulf (15,000 feet below the seabed but in shallow-water depths of less than 656 feet). This estimate is 175 percent greater than the previous projection of 20 tcf just a few years ago. This is a hopeful sign of additional sources of natural gas to meet a portion of the nation's future needs. Natural gas production from this deep shelf area of the Gulf increased from a relatively low 284 billion cubic feet (bcf) in

2000 to 421 bcf in 2002. This 2-year, 50 percent increase follows immediately after a 3-year, 21 percent decrease between 1997 and 2000.[7] To bolster industry interest in this high-cost deep drilling area, in 2001, MMS instituted a program of deep shelf royalty relief for natural gas production. This economic incentive, combined with more sophisticated cost-effective technology, improved seismic data, better understanding of the potential from the deep shelf, and increased public demand, is likely to provide the impetus for even further accelerated natural gas production from the OCS.

Federal Revenues from Offshore Oil and Gas Leasing and Production

The federal government receives substantial sums of revenue from energy companies for offshore oil and gas leasing and production. OCS lessees make three categories of payments: bonus bids when a lease is issued, rental payments before a lease produces, and royalties on any production from the lease. In the half century of the oil and gas program's existence, between 1953 and 2002, it has contributed approximately $145 billion in federal revenues.[8] In recent years, the revenues generated from offshore energy activity have averaged $4–$5 billion annually (Table 24.3). Although most of the revenues have been deposited directly into the U.S. Treasury, a significant portion has gone to the Land and Water Conservation Fund and the National Historic Preservation Fund.

Table 24.3. Federal Revenues from Offshore Mineral Development
Significant funds are paid into the U.S. Treasury each year from outer Continental Shelf (OCS) bonuses, royalties, and rents. This money is used in part to help support federal conservation and preservation programs and a small amount generated from near shore development is shared with some OCS producing states.

Year	Oil and Gas Royalties	Bonuses, Rents and Other Revenue	Total by Year
1997	$3,444,561,989	$1,814,666,046	$5,259,228,035
1998	$2,703,722,873	$1,618,914,459	$4,322,637,332
1999	$2,611,742,229	$576,646,226	$3,188,388,455
2000	$4,094,576,078	$1,115,086,564	$5,209,662,642
2001	$5,448,825,260	$1,056,762,550	$6,505,590,810
Total	**$18,303,428,429**	**$6,182,075,845**	**$24,485,504,274**

Source: Minerals Management Service, Department of Interior. <http://www.mrm.mms.gov/Stats/pdfdocs/coll_off.pdf> (Accessed March, 2004). Year 2001 data courtesy of MMS Revenue Management Office, Lakewood, CO.

A Question of Equity: Sharing OCS Receipts with Coastal States

Mineral resources on federal land, whether onshore or offshore, benefit the nation as a whole. The primary law governing onshore mineral development is the Mineral Leasing Act (MLA), and the comparable law for offshore minerals is the OCSLA. These two statutes are analogous in many ways except for one – the sharing of revenues with states. Under the MLA, each of the lower 48 states directly receives 50 percent of all mineral leasing revenues from public lands within its boundaries and an additional 40 percent through the Reclamation Fund; the state of Alaska receives 90 percent directly. Also, there is a broad array of additional federal land onshore receipts sharing programs, including the National Forest Receipts Program, the Taylor Grazing Act, and others. Eligible uses of the shared receipts vary widely. Some programs require that the funds be used by the recipient jurisdiction for specific purposes such as schools, roads, or land and resource improvements, while others allow the states more discretion.

Furthermore, once leased under the MLA or some other land management statutes, federal onshore lands are generally subject to most state and local taxes; the most noteworthy in many cases is the ability of states to levy severance taxes from minerals developed on federal lands within their borders. Additionally, if local governments lose property tax revenue because of the existence of federal lands, there are a variety of federal agency programs that provide localities with payments in lieu of taxes.

In contrast, the OCSLA specifically prohibits the applicability of state taxes to the OCS. Moreover, there is no comparable general offshore revenue sharing program like the MLA for coastal states. Proponents of such an initiative argue that although the energy development occurs in federal waters outside of coastal state boundaries, many of the impacts resulting from such activity occur locally, in and near the states' coastal zones. They contend that affected states and communities should receive assistance in coping with the costs of facilitating offshore development, including actions to minimize the risk of environmental damage. Officials in the executive branch have traditionally opposed revenue sharing, largely because of the potential loss to the federal treasury.

For decades, Congress has debated proposals to enact a general OCS revenue sharing statute—including the Coastal Energy Impact Program in the mid-1970s—to help states address the effects of offshore production and remedy the apparent inconsistency with onshore mineral development. Disputes over the fair division of revenues from resources discovered in fields that straddle state and federal submerged lands were resolved in 1986. In that year, Congress amended the OCSLA to require that 27 percent of revenues from federal leasing and production activity within three nautical miles seaward of the federal–state offshore boundary be given to the affected state. Through the release of money that was being held in escrow, the awarding of past payments owed to the states, and subsequent entitlement to 27 percent of current and future royalties from the three-mile area, the seven OCS "producing" states have received slightly more than $3 billion since 1986. Currently, this program provides only some $50-60 million annually to such states. In fiscal year 2001, Congress authorized and appropriated $142 million for a Coastal Impact Assistance Program to be allocated among the producing states by the National Oceanic and Atmospheric Administration (NOAA). However, this was a one-year authorization, and no further funding has been provided.

Enhancing the Federal-State Ocean and Coastal Partnership

In various parts of this report, recommendations are made not only to strengthen the coordination of ocean policy and agency organization at the federal level, but also the involvement of non-federal governmental and nongovernmental stakeholders through a formal mechanism of a presidential council of advisors, regional ocean councils, and other less formal structures. In effect, the time has come for a new ocean and coastal partnership between the federal government and state, local, and tribal governments. This partnership should include a recognition that much of the responsibility for the management of the nation's ocean and coastal resources rests with coastal state and local governments. In fact, that recognition is the foundation of the CZMA, permeates many other natural resource management programs, and is specifically acknowledged in Chapter 30.

As the federal-state ocean and coastal partnership began to evolve, the nation determined that the activities associated with development of nonrenewable resources should not be pursued at the expense of the long-term health of renewable resources. That is why the OCSLA, the CZMA, and other applicable federal statutes call for the balanced management of offshore oil and gas, the protection of the ocean and coastal environment, and the involvement of state and local governments. The day will come when oil and gas will no longer be found or developed in the nation's submerged lands, but if the proper policies are pursued, the renewable resources of the estuaries, coasts, oceans, and Great Lakes, and the economic activities that depend upon them, will remain healthy and strong.

To make certain that the federal-state partnership is strengthened and that critical marine ecosystems are protected, more investment of the resource rents generated from OCS energy leasing and production into the sustainability of ocean and coastal resources is necessary. Specifically, some portion of the revenues received by the federal government annually for the leasing and extraction of *nonrenewable* offshore resources need to be allocated to all coastal states for programs and efforts to enhance the conservation and sustainable development of *renewable* ocean and coastal resources. A larger portion of the allocation will need to be granted to the OCS-producing states to help them address the environmental and socioeconomic impacts from offshore oil and gas-related activity. None of the programs that currently receive revenues from OCS oil and gas activity should be adversely affected by this allocation.

Recommendation 24–1. Congress, with input from the National Ocean Council, should ensure that a portion of the revenues that the federal government receives from the leasing and extraction of outer Continental Shelf (OCS) oil and gas is invested in the conservation and sustainable development of renewable ocean and coastal resources through grants to all coastal states. States off whose coasts OCS oil and gas is produced should receive a larger share of such portion to compensate them for the costs of addressing the environmental and socioeconomic impacts of energy activity in adjacent federal waters.

State Involvement in OCS Oil and Gas Decision-making

The partnership between the federal and state governments with respect to activities in federal waters should involve more than the sharing of some revenues. The central role of states in the new ocean policy framework is addressed in practically every chapter of this report. For example, Chapter 6 specifically calls for a more robust federal-regional-state dialogue in the building of coordinated offshore management regime. Chapter 9 addresses the link between coastal and offshore management, including the role of the federal consistency provision of the CZMA, despite some disagreements between levels of government, in enhancing cooperative federalism.

With respect to offshore oil and gas, the 1978 amendments to the OCSLA were intended, among many purposes, to bring state and local governments into much clearer and statutorily specified consultative roles at various points in DOI's decision-making process. Further, the amendments made clear that the federal consistency provision of the CZMA applied to exploration, development, and production plans submitted to the Secretary of the Interior under the OCSLA. (For further information, see the box on "The Federal Consistency Provision and Offshore Oil and Gas Development.")

Environmental Issues Related to Offshore Oil and Gas Production

As with most industrial development activities, along with the economic and energy-related benefits of OCS oil and gas production are actual and perceived risks to the environment, coastal communities, and competing users. Since the 1969 Santa Barbara blowout, the U.S. oil industry's environmental and safety record has improved significantly, as has the regulatory regime of DOI. Today, safety stipulations are more stringent, technologies are vastly improved, inspections are regular and frequent, and oil spill response capabilities are in place. Nevertheless, there remain numerous environmental issues associated with the development and production of oil and gas from the OCS. Foremost among these are:

- physical damage to coastal wetlands and other fragile areas by OCS-related onshore infrastructure and pipelines.
- physical disruption of and damage to bottom-dwelling marine communities.
- discharge of contaminants and toxic pollutants present in drilling muds and cuttings and in produced waters.
- emissions of pollutants from fixed facilities, vessels, and helicopters.
- seismic exploration and production noise impacts on marine mammals and fish and other wildlife.
- immediate and long-term ecological effects of large oil spills.
- chronic, low-level impacts on natural and human environments.
- cumulative impacts on the marine, coastal, and human environments.

The most obvious of these risks and the one most commonly cited, is the potential for oil spills including drill rig blowouts, pipeline spills, and chronic releases from production platforms. The impacts of large oil spills can last from years to decades, particularly in critical habitats, such as wetlands and coral reefs.

The Federal Consistency Provision and Offshore Oil and Gas Development

The application of the federal consistency provision of the CZMA to offshore energy development has been among the most contentious issues among the federal government, coastal state governments, and OCS lessees. In the mid 1970's, Congress amended the original version of the federal consistency provision to add a section that explicitly covered certain OCS activities. Of the thousands of exploration and development plans submitted by oil and gas companies over the years and approved by MMS, states have concurred with the consistency of such plans with their state coastal management program in virtually all of the cases. But there have been a handful in which states have objected and these are generally cases of high visibility, of which fifteen have been appealed to the Secretary of Commerce. These appeals resulted in fourteen decisions by the Secretary, half of which overrode the state's objection and half did not.

In a case that reached the highest court in the land in 1984, the U.S. Supreme Court held that OCS lease sales were not subject to the consistency provision of the CZMA. In 1990, Congress enacted a law which reversed the decision, clarified that such sales are subject to a state consistency review, and made a number of other changes to the interpretation of the federal consistency provision that resulted in a lengthy rule-making process by NOAA. The final rule was published in 2000.

In 2001, the Vice President submitted the National Energy Policy report of the National Energy Policy Development Group to the President.[9] The report contained a section on the OCSLA, as administered by MMS, and the CZMA, as carried out by NOAA. It noted that the effectiveness of these programs is "sometimes lost through a lack of clearly defined requirements and information needs from federal and state entities, as well as uncertain deadlines during the process." The report recommended that the Secretaries of Commerce and the Interior reexamine the legal and policy regimes to see if changes were needed regarding energy activities in the coastal zone and the OCS.

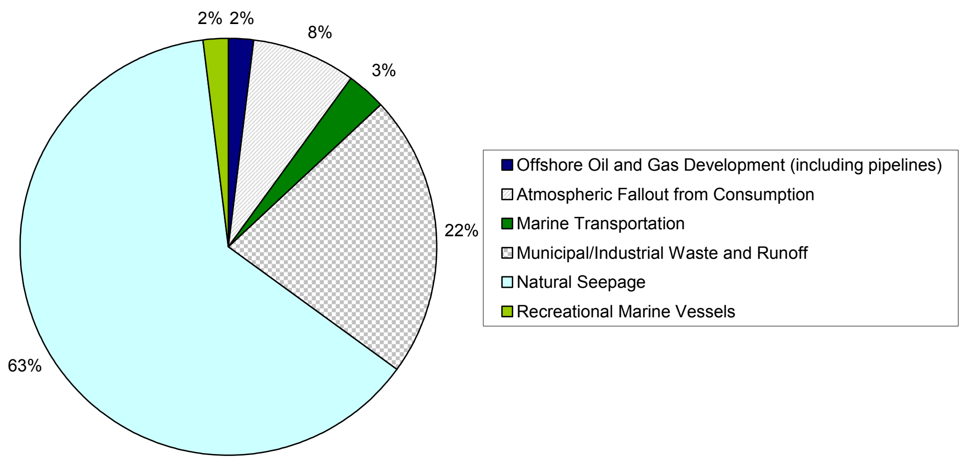
In 2003, after a series of negotiations between the two departments, the Department of Commerce published a proposed rule addressing the information needs of states, coordination of timing requirements between the OCSLA and the CZMA, definitive time limits on the Secretary of Commerce's appeals process, and additional procedural matters. (For a more detailed discussion of the OCS-specific federal consistency provisions of the CZMA and the issues related to their implementation, including a history of related litigation, see Appendix 6.)

According to MMS, 97 percent of OCS spills are one barrel or less in volume and U.S. OCS offshore facilities and pipelines accounted for only 2 percent of the volume of oil released into U.S. waters for the period 1985-2001 (Figure 24.4).[10] The total volume and number of such spills over that period have been significantly declining due to industry safety practices and improved spill prevention technology. By comparison, the National Research Council estimated that 690,000 barrels of oil enter North American ocean waters each year from land-based human activities, and another 1,118,000 barrels result from natural seeps emanating from the seafloor.[11]

However, spills from aging pipelines are a continuing concern. Since 1981, the volume of oil spilled from OCS pipelines is four to five times greater than that from OCS platforms (Figure 24.5).[12] Long-term exposure to weather and marine conditions make pipelines older than 25 years considerably more susceptible to spills and leaks as a result of stress fractures and material fatigue. Also, these older pipelines do not incorporate the advanced oil spill detection and prevention technology that has been developed in more recent years.

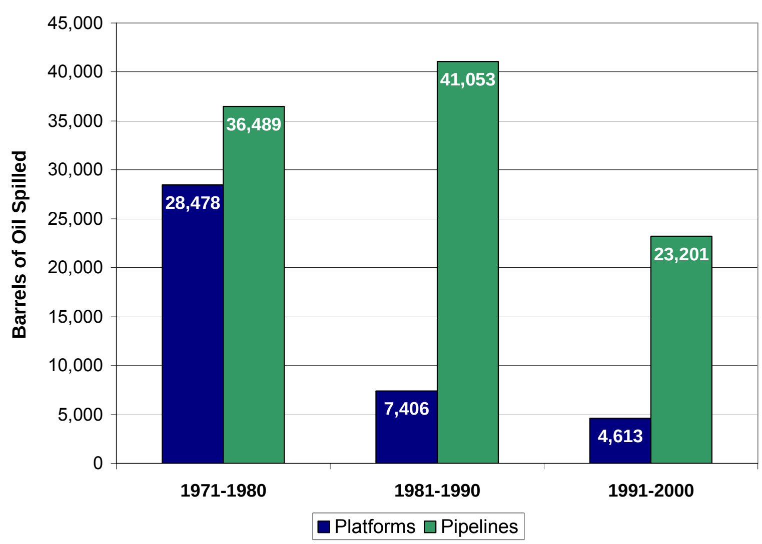
MMS's Environmental Studies Program (ESP) is a major source of information about the impacts of OCS oil and gas activities on the human, marine, and coastal environments. Since 1986, annual funding for the program has decreased, in real dollars, from a high of $56 million to approximately $18 million in 2003. Even accounting for the contraction in the areas available for leasing, the erosion in ESP funding has occurred at a time when more and better information, not less, is needed. There continues to be a need to better understand the cumulative and long-term impacts of OCS oil and gas development, especially in the area of low levels of persistent organic and inorganic chemicals, and their cumulative or synergistic effects.

Figure 24.4. Sources of Oil in the North American Marine Environment



Offshore oil and gas development contributes only 2 percent of the 1.8 million of barrels of oil released into North American waters each year. Natural seepage from the sea floor is by far the largest input, while runoff and waste from human land-based activities contribute roughly a quarter of the oil present in the marine environment. When calculated worldwide, the oil released from offshore oil and gas development still only accounts for 4 percent of the total 8.9 million barrels. (One barrel is equal to 42 gallons.)
Source: Minerals Management Service. *OCS Oil Spill Facts*, 2002. <http://www.mms.gov/stats/PDFs/2002_OilSpillFacts.pdf> (Accessed March, 2004).

Figure 24.5. Aging Pipelines are a Leading Source of Oil Leaks from OCS Infrastructure



In the last thirty years, the amount of oil spilled from OCS platforms and pipelines has continued to decrease. However, the increasing disparity between the number of barrels spilled from platforms versus pipelines indicates that the pipeline infrastructure—which is more exposed to the effects of weather and saltwater—needs updating to prevent future spills.
Source: Minerals Management Service. *OCS Oil Spill Facts*, 2002. <http://www.mms.gov/stats/PDFs/2002_OilSpillFacts.pdf> (Accessed March, 2004).

Also, as noted, OCS oil and gas exploratory activities in the Gulf of Mexico are now occurring in water depths approaching 10,000 feet with projections that the industry will achieve 15,000 feet drilling capabilities within the next decade. The technological ability to conduct oil and gas activities in ever deeper waters on the OCS places a significant and important responsibility on MMS to collect the essential environmental deep-water data necessary for it and other agencies to make informed management and policy decisions on exploration and production activities at those depths. Thus, as our knowledge base increases and the industry expands its activities further offshore and into deeper waters, new environmental issues are emerging that cannot all be adequately addressed under the current ESP budget.

Recommendation 24–2. The U.S. Department of the Interior should reverse recent budgetary trends and increase funding for the Minerals Management Service's Environmental Studies Program.

Increased funding should be used for:

- *conducting long-term environmental monitoring at appropriate outer Continental Shelf (OCS) sites to better understand cumulative, low-level, and chronic impacts of OCS oil and gas activities on the natural and human environments.*
- *working with state environmental agencies and industry to evaluate the risks to the marine environment posed by the aging offshore and onshore pipelines in the Gulf of Mexico.*

Opportunities for Sharing Ocean Observation Information and Resources

Floating drilling rigs and production platforms are able to maintain position over the tops of wells thousands of feet below without the need for mooring or permanent structures. Dynamic positioning systems compensate for wind, waves, or currents to keep the vessel stationary relative to the seabed, and new hull designs maintain stability. Three- and four-dimensional subsurface images allow operators to obtain a better idea of how a reservoir behaves and increase the likelihood of drilling success. And the use of horizontal and directional drilling creates more flexibility in deciding where to site offshore platforms.

The movement of oil and natural gas exploration, development, and production activities further offshore into deeper waters and into more harsh marine environments, such as the Arctic, affords an excellent opportunity for incorporating the industry's offshore infrastructure into the national Integrated Ocean Observing System (IOOS), as discussed in Chapter 26. In addition to its offshore infrastructure, the industry has great technological capacity for collecting, assimilating, and analyzing environmental data of direct importance to the IOOS. The U.S. offshore industry has a history of partnering with ocean scientists by allowing them to use production platforms for mounting environmental sensors, and in some cases, collecting and providing them with environmental data and information. The industry would benefit from partnering in the IOOS as a user of the system's data and information products and by being involved in its design, implementation, and future enhancement.

Recommendation 24–3. The National Oceanic and Atmospheric Administration, working with the Minerals Management Service and the offshore oil and gas industry, should establish a partnership that will allow the use of industry resources, including pipelines, platforms, vessels, and research and monitoring programs, as part of the Integrated Ocean Observing System (IOOS).

Specifically, this partnership should:

- *facilitate the transfer of nonproprietary data to research and academic institutions while protecting the security of proprietary data and meeting other safety, environmental, and economic concerns.*
- *include the offshore oil and gas industry as an integral partner in the design, implementation, and operation of the IOOS, notably in the regional observing systems in areas where offshore oil and gas activities occur.*

Assessing the Potential of Offshore Methane Hydrates

Conventional oil and gas are not the only fossil-based fuel sources located beneath ocean floors. Methane hydrates are solid, ice-like structures composed of water and natural gas. They occur naturally in areas of the world where methane and water can combine at appropriate conditions of temperature and pressure, such as in thick sediments of deep ocean basins, at water depths greater than 500 meters.

The estimated amount of natural gas in the gas hydrate accumulations of the world greatly exceeds the volume of all known conventional gas resources.[13] A 1995 U.S. Geological Survey (USGS) estimate of both marine and Arctic hydrate resources revealed the immense energy potential of hydrates in the United States.[14] These deposits have been identified in Alaska, the east and west coasts of the United States, and in the Gulf of Mexico. USGS estimated that the methane hydrates in U.S. waters hold a mean value of 320,000 trillion cubic feet of natural gas, although subsequent refinements of the data have suggested that the estimate is a slightly more conservative 200,000 trillion cubic feet.[15] Even this more conservative estimate is enough to supply all of the nation's energy needs for more than 2,000 years at current rates of use.[16]

However, there is still no known practical and safe way to develop the gas and it is clear that much more information is needed to determine whether significant technical obstacles can be overcome to enable methane hydrates to become a commercially viable and environmentally acceptable source of energy.

In the United States, federal research concerning methane hydrates has been underway since 1982, was intensified in 1997-98, and received further emphasis with the passage of the Methane Hydrate Research and Development Act in 2000. That Act established an interagency coordination mechanism that includes the Departments of Energy, Commerce, Defense, and the Interior, and the National Science Foundation, and directed the National Research Council (NRC) to conduct a study on the status of research and development work on methane hydrates. The NRC study is scheduled for release in September 2004.

Recommendation 24–4. The National Ocean Council (NOC), working with the U.S. Department of Energy and other appropriate entities, should review the status of methane hydrates research and development and seek to determine whether methane hydrates can contribute significantly to meeting the nation's long-term energy needs. If such contribution looks promising, the NOC should determine how much the current investment in methane hydrates research and development efforts should be increased, and whether a comprehensive management regime for private industry access to methane hydrates deposits is needed.

Developing Offshore Renewable Energy Resources

Environmental, economic, and security concerns have heightened interest among many policy makers and the public in renewable sources of energy. Although offshore areas currently contribute little to the nation's supply of renewable energy, the potential is significant and could include offshore wind turbines, mechanical devices driven by waves, tides, or currents, and ocean thermal energy conversion, which uses the temperature difference between warm surface and cold deep ocean waters to generate electricity.

Offshore Wind Energy Development

While the offshore wind power industry is still in its infancy in the United States, it is being stimulated by improved technology and federal tax credits that have made it more attractive commercially. Additionally, developers are looking increasingly to the lead of European countries such as Denmark, the United Kingdom, and Germany, where growing numbers of offshore projects are being licensed.

In fact, the United States already has a wind energy management program applicable on some federal lands onshore. This comprehensive program carried out by DOI's Bureau of Land Management, under broad authority provided by the Federal Land Policy and Management Act.

Conversely, there is no comprehensive and coordinated federal regime in place to regulate offshore wind energy development or to convey property rights to use the public space of the OCS for this purpose. In the absence of a specific regime, the U.S. Army Corps of Engineers (USACE) is the lead federal agency responsible for reviewing and granting a permit for this activity. Its authority, however, is based on Section 10 of the Rivers and Harbors Act, which, although it has a public interest requirement, primarily regulates obstructions to navigation, including approval of any device attached to the seafloor.

In reviewing a proposed project under Section 10, the USACE is required by the National Environmental Policy Act to consult other federal agencies. Depending on the circumstances, these agencies and authorities may include:

- The U.S. Coast Guard, which regulates navigation under several federal statutes.
- The Federal Aviation Administration, which regulates objects that may affect navigable airspace pursuant to the Federal Aviation Act.
- The U.S. Environmental Protection Agency, which may conduct a review for potential environmental impacts of a project pursuant to the Clean Water Act and Clean Air Act.
- The National Marine Fisheries Service, which may review projects for potential impacts to fishery resources pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. In addition, NMFS review includes assessing potential impacts to endangered or threatened species under the Endangered Species Act or the Marine Mammal Protection Act.
- The U.S. Fish and Wildlife Service, which may review projects for potential impacts to endangered species or marine mammals under its jurisdiction pursuant to the Endangered Species Act or the Marine Mammal Protection Act.
- In addition, depending on its location, a wind energy project or at least the Section 10 permit may be subject to review by one or more state coastal management programs in accordance with the CZMA federal consistency provisions.

The Section 10 review process stands in stark contrast both to the well established DOI regulatory program for onshore wind energy and, in the marine setting, to the robust regulatory program for offshore oil and gas that has developed under the OCSLA. Using the Section 10 process as the primary regulatory vehicle for offshore wind energy development is inadequate for a number of reasons. First and foremost, it cannot grant leases or exclusive rights to use and occupy space on the OCS. It is not based on a comprehensive and coordinated planning process for determining when, where, and how this activity should take place. It also lacks the ability to assess a reasonable resource rent for the public space occupied or a fee or royalty for the energy generated. In other words, it lacks the management comprehensiveness that is needed to take into account a broad range of issues, including other ocean uses in the proposed area and the consideration of a coherent policy and process to guide offshore energy development.

A Mighty Wind Blows in Cape Cod

The first proposal for offshore wind energy development in the United States is testing the ability of the federal system to manage this emerging industry. The proposal calls for use of approximately 23 square miles of Nantucket Sound, some 5.5 nautical miles off the coast of Cape Cod, Massachusetts. It would consist of 170 wind turbines, each of which would be sunk into the ocean floor and reach up to 420 feet above the ocean surface. The project would generate an annual average of approximately 160 megawatts of electrical power.[17]

This project has divided local citizens, elected officials, environmentalists, business interests, and other stakeholders. Supporters cite the project's potential to reduce pollution, global warming, and reliance on foreign oil, while opponents warn of bird deaths, harm to tourism, interference with commercial and sports fishing, and obstructed views.

Despite the controversy, the project is proceeding through the Section 10 review process. In the meantime, proposals for offshore wind development projects up and down the East Coast are proliferating.

Wave Energy Conversion—Current and Tidal

Various technologies have been proposed to use wave or tidal energy, usually to produce electricity. The wave energy technologies for offshore use include floating or pitching devices placed on the surface of the water that convert the horizontal or vertical movement of the wave into mechanical energy that is used to drive a turbine. Currently, the offshore wave, tidal, and current energy industry is in its infancy. Only a small proportion of the technologies have been tested and evaluated.[18] Nonetheless, some projects are moving forward in the United States, including one to install electricity-producing wave-energy buoys more than three nautical miles offshore Washington State, in the Olympic Coast National Marine Sanctuary. Internationally, there is considerable interest in wave, tidal, and current energy, but the projects are almost all in the research and development stage.

The Federal Energy Regulatory Commission (FERC) asserts jurisdiction, under the Federal Power Act (FPA), over private, municipal, and state (not federal) hydropower projects seaward to 12 nautical miles. FERC has formally asserted jurisdiction over the Washington State project, and is likely to assert jurisdiction over all forms of wave or tidal or current energy projects whose output is electricity, from the shoreline out to 12 nautical miles offshore, on the basis that they are "hydropower" projects under the FPA.

Although in issuing a license for a wave, current, or tidal project FERC is directed by the FPA to equally consider environmental and energy concerns, it is not an agency with a broad ocean management mission. As with wind energy, several other federal laws may apply to ocean wave projects. For example, NEPA, the federal consistency provision of the CZMA, the National Historic Preservation Act, and the Fish and Wildlife Coordination Act may apply, as may the consultation provisions of the Endangered Species Act and the Marine Mammal Protection Act. But there is no comprehensive law that makes clear which of these individual laws may be applicable, nor is there any indication that overall coordination is a goal, thus leaving implementation, again, to mixed federal authorities.

Ocean Thermal Energy Conversion

The surface waters of the world's tropical oceans store immense quantities of solar energy. Ocean thermal energy conversion (OTEC) technology could provide an economically efficient way to tap this resource to produce electric power and other products. The U.S. government spent over $200 million dollars in OTEC research and development from the 1970s to the early 1990s that produced useful technical information but did not result in a commercially viable technology. [19]

Early optimism about the potential of OTEC led to the enactment of the Ocean Thermal Energy Conversion Act of 1980, and the creation of a coordinated framework and licensing regime for managing that activity if and when economic considerations permitted. NOAA issued regulations to implement the Act, but because of investor risk for this capital-intensive technology and relatively low fossil fuel prices, no license applications were ever received and NOAA subsequently rescinded the regulations in 1996. Thus, the United States currently has no administrative regulatory structure to license commercial OTEC operations.

Comprehensive Management for Offshore Renewable Energy

Offshore renewable technologies will continue to be studied as a means of reducing U.S. reliance on potentially unstable supplies of foreign oil, diversifying the nation's energy mix, and providing more environmentally benign sources of energy. Similar to offshore aquaculture described in Chapter 22, the offshore renewable processes described in this section present obvious examples of the shortcomings in federal authority when it comes to regulating specific new and emerging offshore activities. As long as federal agencies are forced to bootstrap their authorities to address these activities, the nation runs the risk of unresolved conflicts, unnecessary delays, and uncertain procedures. What is urgently needed is a comprehensive offshore management regime, developed by the National Ocean Council, which is designed to review all offshore uses in a greater planning context (see Chapter 6). A coherent and predictable federal management process for offshore renewable resources that is able to weigh the benefits to the nation's energy future against the potential adverse effects on other ocean users, marine life, and the ocean's natural processes, should be fully integrated into the broader management regime.

Recommendation 24–5. Congress, with input from the National Ocean Council, should enact legislation providing for the comprehensive management of offshore renewable energy development as part of a coordinated offshore management regime.

Specifically, this legislation should:

- *streamline the process for licensing, leasing, and permitting renewable energy facilities in U.S. waters.*
- *subsume existing statutes, such as the Ocean Thermal Energy Conversion Act, and should be based on the premise that the oceans are a public resource.*
- *ensure that the public receives a fair return from the use of that resource and development rights are allocated through an open, transparent process that takes into account state, local, and public concerns.*

MANAGING OTHER MARINE MINERALS

The ocean floor within the U.S. EEZ contains vast quantities of valuable minerals other than oil and gas, but the economics of recovering them, especially in areas far offshore, are not welcoming. These resources include more than two trillion cubic meters of sand and gravel reserves on the Atlantic shelf of the OCS alone, enormous phosphate deposits off the East Coast from North Carolina to northern Florida, titanium-rich heavy mineral sands from New Jersey to Florida, manganese nodules from South Carolina to Georgia, gold deposits off of Alaska, polymetallic sulfides off of Oregon, barite resources off of southern California, and quantities of cobalt and platinum in Hawaii. It is likely that substantial amounts of other valuable minerals will be identified in the future as exploration proceeds. Access to these minerals for commercial recovery, including offshore sand and gravel for use as construction aggregate, is through the competitive leasing process of the OCSLA.

In 1994, Congress authorized coastal communities to use sand and gravel from the OCS for public works projects without going through the statute's bidding process. Since then, MMS has used this authority to allow federal, state, and local agencies to mine OCS sand to protect shorelines, nourish beaches, and restore wetlands. Between 1995 and 2004, MMS provided over 20 million cubic yards of OCS sand for 14 coastal projects.[20] Louisiana alone is expected to seek millions of cubic yards of OCS sand for various barrier island restoration projects and levee systems.[21]

The depletion of OCS sand in state waters after decades of excavation, and growing environmental opposition to the activity in areas close to shore are exacerbated by the acceleration of erosion, ever-expanding coastal populations, and on the increasing vulnerability of fragile beaches, exposed beachfront property, and coastal-dependent industries to coastal storms. With the need for sand increasing and its availability in state waters decreasing, the OCS provides the obvious remedy. It is not, however, a remedy without associated problems.

MMS has numerous environmental studies underway or planned to evaluate the effects of OCS dredging on the marine and coastal environment and to identify ways to eliminate or mitigate harmful impacts. There remains, nevertheless, significant uncertainty about the long-term, cumulative impacts of sand and gravel mining on ocean systems and marine life. Changes in bathymetry can affect waves and currents in a manner that could increase shoreline erosion. Alterations to the ocean bottom can affect repopulation of the benthic community, cause increased turbidity, damage submerged resources such as historic shipwrecks, and kill marine organisms, including fish. For economic reasons, the demand for sand and gravel leases will most likely concentrate on OCS areas that are relatively close to shore. Some environmentalists and fishing representatives have opposed mining in state waters and may well oppose similar projects in adjacent federal waters.

A vital component of a national strategy to manage mineral resources located on the OCS is the need for an overall assessment of: (1) the nation's OCS mineral endowment (sand and gravel, as well as other strategic minerals vital to the long-term security of the nation); (2) the need for those resources (highest and best uses); (3) the long-term environmental impacts associated with use of those resources and; (4) the multiple-use implications of other uses of the OCS (including wind farms, cables, and pipelines). While resource managers have identified large volumes of sand off the nation's shores, the ultimate volumes that may be recovered remain unknown. Sand and gravel resources from the OCS are key to protecting the nation's shores and wetlands and to supplementing ever-diminishing onshore supplies of aggregate to support construction activities.

Recommendation 24–6. The Minerals Management Service should systematically identify the nation's offshore non-energy mineral resources and conduct the necessary cost-benefit, long-term security, and environmental studies to create a national program that ensures the best uses of those resources.

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Part VII
Science-based Decisions: Advancing Our Understanding of the Oceans

Chapter 25: Creating A National Strategy For Increasing Scientific Knowledge

Ocean managers and policy makers need comprehensive scientific information about the ocean and its environment to make wise decisions. Increased knowledge can support sustainable resource use, economic development, and conservation of the ocean's biological diversity and natural beauty. A national strategy is needed to ensure the highest return on the nation's investment in ocean research, exploration, and marine operations. The strategy should coordinate and prioritize basic and applied research supported by federal agencies, increase partnerships with the academic and private sectors, promote enhanced ocean exploration, and coordinate federal marine operations to reduce redundancies. Significantly increased funding for research in ocean-related natural and social sciences and a renewed commitment to ocean exploration are keys to fostering a new era of ecosystem-based management supported by science.

Fortifying the Foundations of Ocean Understanding

Ocean science and technology are integral parts of the overall U.S. research enterprise and contribute greatly to society. They are essential to understanding the Earth's environment and how it changes over time, managing marine resources wisely, finding beneficial new uses of ocean resources, and protecting national security. In addition, important technological advances have resulted from devices originally developed for ocean research and exploration, such as medical acoustic tools that grew out of sonar technologies.

Components of Ocean Science and Technology

For the purpose of this and the following three chapters of Part VII, ocean science and technology is defined as:

- the exploration of ocean environments, and the conduct of basic and applied research to increase understanding of (1) the biology, chemistry, physics, and geology of the oceans and coasts, (2) oceanic and coastal processes and interactions with terrestrial, hydrologic, and atmospheric systems, and (3) the impacts of oceans and coastal regions on society and of humans on these environments; and
- the development of methodologies and instruments to improve that understanding.

Knowledge about the oceans advanced remarkably during the 20th century due to significant financial investments, a host of multidisciplinary and interdisciplinary studies, new technologies, and an expanding community of dedicated experts. Despite this progress, the ocean remains one of the least explored and understood environments on the planet—a frontier for discoveries that could provide important benefits. A broader understanding of coastal waters and the deep ocean is essential to enable the practice of ecosystem-based, multi-use, and adaptive management and to conserve biodiversity. Ocean science and technology will play an increasingly central role in the multidisciplinary study and management of the whole-Earth system.

The chapters of Part VII focus on four building blocks of a renewed and restructured U.S. commitment to ocean science and technology:
1) a national strategy for conducting research, exploration, and marine operations at the federal level and in partnership with academia and private organizations (Chapter 25);
2) an integrated ocean observing system to better measure and predict ocean conditions and processes (Chapter 26);
3) the infrastructure and technology development needed to conduct and support ocean science (Chapter 27); and
4) data and information management to handle and manipulate research data and generate useful products for resource managers and the general public (Chapter 28).

Federal Leadership in Ocean Science and Technology

Since the mid-1900s, the U.S. government has assumed a leadership role in ocean science and technology. Today, fifteen federal agencies support or conduct diverse activities in ocean research, assessment, and management. The heads of these agencies direct the National Oceanographic Partnership Program (NOPP), which coordinates national oceanographic research and education. NOPP has provided a useful venue for agencies to support selected ocean science and technology projects, but it has not realized its full potential as an overarching mechanism for coordination among federal agencies or between federal activities and those of state, local, academic, and private entities.

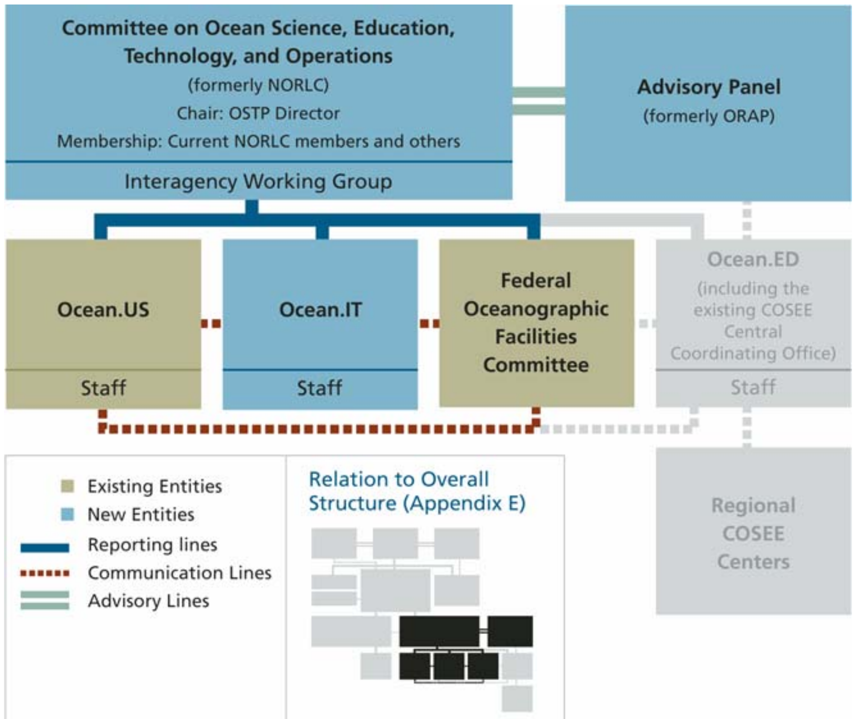
Under the new National Ocean Policy Framework proposed in Chapter 4, the National Ocean Council (NOC) will serve as the federal coordinating body for all ocean-related activities and the NOC's Committee on Ocean Science, Education, Technology, and Operations (COSETO) will assume leadership of NOPP. This new structure will allow for the design and implementation of a national strategy to promote ocean research, education, observation, exploration, and marine operations. NOPP's existing offices and committees will be incorporated within this structure (Figure 25.1). Ocean.US, the lead office for planning the Integrated Ocean Observing System (IOOS), and the Federal Oceanographic Facilities Committee, which provides advice related to oceanographic facilities, will both report to COSETO. An additional planning and coordinating body, Ocean.IT should be added to COSETO to provide stronger integration for information technology activities. (The creation of Ocean.IT is discussed in Chapter 28.)

Establishing a National Strategy

The United States does not have a national strategy for ocean and coastal research, exploration, and marine operations that can integrate ongoing efforts, promote synergies among federal, state, and local governments, academia, and the private sector, translate scientific and technological advances into operational applications, and establish national goals and objectives for addressing high-priority issues. Instead, for the most part, each federal ocean agency independently addresses its own specific information needs.

A national strategy can help meet the ocean resource management challenges of the 21st century and ensure that useful products result from federal investments in ocean research. Moving toward ecosystem-based management approaches will require a new generation of scientific understanding. Specifically, more needs to be known about how marine ecosystems function on varying spatial scales, how human activities affect marine ecosystems and how, in turn, these changes affect human health.

Figure 25.1. Proposed Structure for the Coordination of Federal Ocean Research Activities



Shown here are the institutional components that should be established under the National Ocean Council's Committee on Ocean Science, Education, Technology, and Operations (COSETO) recommended in Chapter 4. COSETO's purpose is to improve federal leadership and coordination in ocean science, education, technology, and marine operations. This diagram also illustrates the organizational links between the new Ocean.IT and other existing and planned units under COSETO. Entities shaded in gray are discussed in Chapters 4 and 8.

Ecosystem-based management will also require a deeper understanding of biological, physical, chemical, and socioeconomic processes and interactions. For example, as coastal population growth feeds a demand for new construction, managers will need to know which activities may cause rapid erosion of the beach, increased turbidity that harms a coral reef, or economic disruption. In another example, fishery conservation can be promoted by protecting spawning grounds and other essential habitat; to make this possible, scientists and managers must understand the fundamental biology of the fish species.

Maintaining overall ecosystem health also requires an improved understanding of biological diversity on different levels, including genetic diversity (the variety of genetic traits within a single species), species diversity (the number of species within an ecosystem), and ecosystem diversity (the number of different ecosystems on Earth). The largest threats to maintaining diversity on all three scales are human activities, such as overfishing, pollution, habitat alteration, and introductions of non-native species. The extent of marine biological diversity, like so much about the ocean, remains unknown. But based on the rate at which new species are currently being discovered, continued exploration of the ocean is almost certain to result in the documentation of many additional species that can provide fresh insights into the origin of life and human biology.

A national strategy should promote the scientific and technological advances required to observe, monitor, assess, and predict environmental events and long-term trends. Foremost in this category is climate change. The role of the ocean in climate, although critical, remains poorly understood. The ocean has 1000 times the heat capacity of the freshwater lakes and rivers, ocean circulation drives the global heat balance, and ocean biochemistry plays a primary role in controlling the global carbon cycle.

The process of climate change should be examined both on geologic time scales, such as the transitions between ice ages, and over shorter periods of time. The buildup of greenhouse gases in the atmosphere will increase the melting of polar ice, introducing large quantities of fresh water into the North Atlantic. Many researchers now believe that could drastically change ocean circulation and weather patterns in the span of a couple of years.[1] In particular, the Gulf Stream could slow or stop, causing colder temperatures along the eastern seaboard of the United States and ramifications around the globe. It is in man's interests to learn more about the processes that lead to abrupt climate changes, as well as their potential ecological, economic, and social impacts.

Even as we try to comprehend the role of the ocean in climate change, we need also to understand the effects of climate change on ocean ecosystems. If temperatures around the globe continue to warm, sea level will continue to rise, putting many coastal residents at greater risk from storm surges and erosion. For individual ecosystems, even small changes in ocean temperature can put the health and lives of sea creatures and humans at risk. Ocean monitoring, through programs like the IOOS, will be essential for detecting and predicting changes more accurately, thereby improving prospects for minimizing harmful effects.

Some large initiatives, such as the U.S. Climate Change Science Program and the Census of Marine Life, have been launched in the last couple of years to study large-scale research topics. However, many of the issues most relevant to the needs of coastal managers do not occur on such global scales. Due to the regional nature of many ocean and coastal ecosystem processes, regional-scale research programs are also needed. Currently, insufficient emphasis is placed on this kind of research. The regional ocean information programs discussed in Chapter 5 are designed to close this gap and increase our understanding of ocean and coastal ecosystems by prioritizing, coordinating, and funding research that meets regional and local management needs.

At the state level, the National Oceanic and Atmospheric Administration's (NOAA's) National Sea Grant College Program can make essential contributions to achieving research goals. The state Sea Grant programs have the organization and infrastructure necessary to fund research and conduct educational activities that will expand understanding of ocean ecosystems up and down our coasts. Sea Grant's current strategic plan focuses on promoting ecosystem-based management and on involving constituencies from government, universities, the public and the private sector, all of whom are needed to strengthen the U.S. research enterprise.[2]

It is time for the United States to establish a national strategy for ocean research investments, and oversee implementation and funding of programs throughout the ocean science community. This plan should address issues at the global, regional, state, and local levels. It should emphasize ecosystem-based science to help resolve the current mismatch between the size and complexity of marine ecosystems and the fragmented nature of science and the federal structure. Better coordination and integration will help provide the information needed to sustain resources, protect human lives and property, identify and nurture new beneficial uses, and resolve issues that result from competing activities. A unified national approach to ocean research, exploration, and marine operations, structured around national investment priorities, will also result in wiser and more efficient use of resources.

Advancing Ocean and Coastal Research

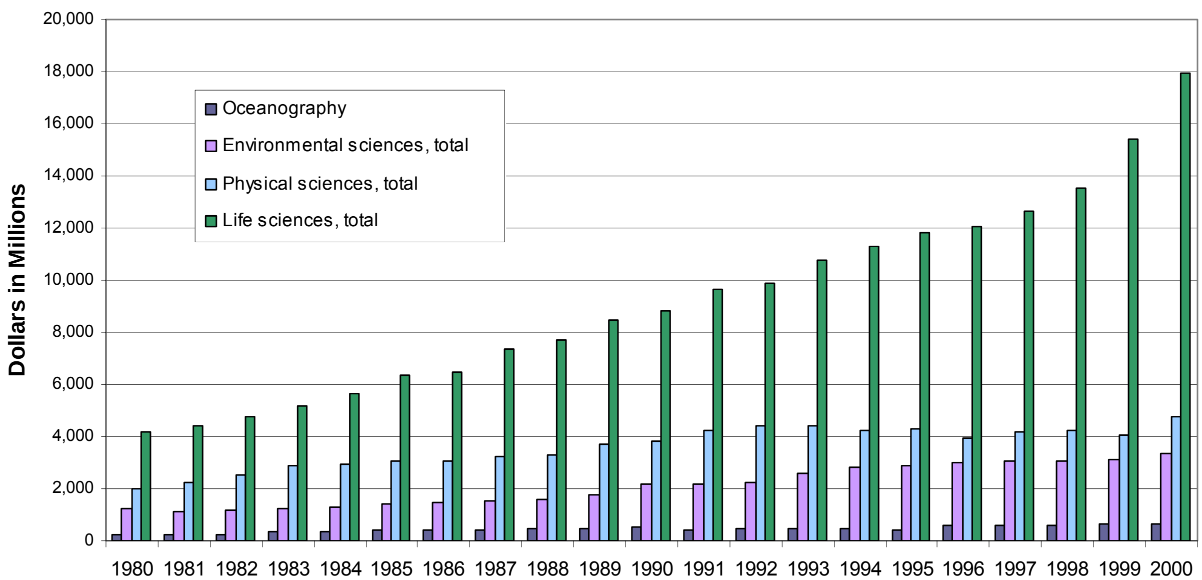
Better coordination of ocean and coastal research is needed at all levels and across all sectors. Increases in funding, changes in grant practices, and the establishment of new partnerships are all essential to maximize the national research enterprise. Advances in social science and economic research are particularly important to generate information needed for the wise management of ocean resources.

Reviving the Federal Investment

The United States has a wealth of ocean research expertise spread across a network of government and industry laboratories and world-class universities, colleges, and marine centers. With strong federal support, these institutions made the United States the world leader in oceanography during the 20th century. However, a leader cannot stand still. Ocean and coastal management issues continue to grow in number and complexity, new fields of study have emerged, new interdisciplinary approaches are being tried, and there is a growing need to understand the ocean on a global and regional scale. All this has created a corresponding demand for high-quality scientific information.

Federal investments during the cold war years of the 1960s and 1970s enabled scientists to help promote our national economy and security through research into the fundamental physical, chemical, biological, and geological properties of the oceans. During that period, ocean research funding constituted 7 percent of the federal research budget. However, the federal investment in ocean research began to stagnate in the early 1980s, while investments in other fields of science continued to grow (Figure 25.2).[3] As a result, ocean research investments comprise a meager 3.5 percent of today's federal portfolio.

Figure 25.2. Ocean Research Neglected as Part of the National Research Budget



Funding for oceanography has remained stagnant for twenty years while other scientific disciplines have experienced steady increases in research funding.
Source: National Science Foundation. *Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1951–2002*. <http://www.nsf.gov/sbe/srs/nsf03325/> (Accessed January, 2004).

The current annual federal investment of approximately $650 million in marine science is well below the level necessary to address adequately the nation's needs for coastal and ocean information. Unless funding increases sharply, the gap between requirements and resources will continue to grow and the United States will lose its position as the world's leader in ocean research.

Recommendation 25–1. Congress should double the federal ocean and coastal research budget over the next five years, from the 2004 level of approximately $650 million to $1.3 billion per year.

A portion of these new funds should be used to:

- *support regional research, directed by the regional ocean information programs discussed in Chapter 5.*
- *significantly enlarge the National Sea Grant College Program.*
- *support other high priority research areas, as outlined throughout this report.*

Coordination and Prioritization

To ensure that increased investments are used wisely and that important research activities continue, federal agencies will need to create long-term strategic plans and remedy structural problems in their grant mechanisms.

In creating long-term plans, a balance must be reached between funding basic, curiosity-driven research conducted mostly at universities and marine research centers and more applied research conducted largely at government laboratories to support operations, management, and monitoring activities. Over time, changes in national priorities may shift the balance slightly between basic and applied research but the enduring value, and often unexpected outcomes, of basic research should never be underestimated. Basic oceanographic research in the 1940s, 1950s, and 1960s increased our understanding of ocean currents, marine acoustics, seafloor geology, and robotics, and basic research supported by the U.S. Navy has led to many widely-used and versatile new technologies, such as the Global Positioning System. Improved cooperation between federal labs and academic institutions can combine the strengths of both, ensure that quality research is conducted, and achieve a balance between basic and applied science.

Problems in the current system for awarding federal research grants make it difficult to conduct the kind of interdisciplinary, ecosystem-based research required to understand the ocean environment. Short-term research grants of two- to five-years duration are now typical. This type of funding is useful for research on discrete topics of limited scope, and has the advantage of giving agencies the flexibility to adjust quickly to changing priorities. However, it is not adequate to acquire the continuous data sets that will be essential for examining environmental changes over time.

In addition, a variety of mechanisms are used by federal agencies to review proposed ocean research grants. Some of these mechanisms work better than others. Grant review systems that are not open to all applicants or that do not use an objective review process for ranking proposals are unlikely to produce the highest quality research. Systems that favor established researchers to the detriment of young scientists, whether intentionally or not, are also flawed, stifling diversity and limiting the infusion of new ideas. When all research proposals, including those from scientists working at federal labs, are subject to the same rigorous review process, tax dollars are more likely to support the best science. Streamlined grant application and review processes will also help get more good science done in a timely way.

The ocean science community includes many scientists outside academic and federal labs. Although coordination among sectors has steadily improved, the process remains mainly ad hoc, without the backing of a national strategy and leadership. A clearer understanding of the respective strengths and roles of the different sectors could lead to productive new research partnerships, foster intellectual risk-taking, leverage funding, and encourage participation in large multi-sector research efforts valuable to the nation.

There is also a need to gain feedback from managers at state and federal levels and from the private sector that can guide new research directions and technology development. The regional ocean information programs recommended in Chapter 5 will provide an excellent mechanism for gaining input on user needs and regional research priorities.

A mechanism is required to coordinate federally funded ocean research (both basic and applied), support long-term projects, and create partnerships throughout all agencies and sectors. Transparent and comprehensive research plans would achieve these goals and ensure that research results can be translated into operational products in a timely manner.

Recommendation 25–2. The National Ocean Council should develop a national ocean research strategy that reflects a long-term vision, promotes advances in basic and applied ocean science and technology, and guides relevant agencies in developing ten-year science plans and budgets.

The national strategy should:

- *require agencies to provide multi-year (greater than 5 year) funding opportunities.*
- *reiterate the importance of balancing basic and applied research projects.*
- *promote the transition of basic research results to applied uses.*
- *require a system of independent review for all grant applications, including those from federal labs.*
- *recognize the different ocean science sectors (government, academic, commercial, and non-governmental), clarify their roles, and maximize the use of partnerships.*
- *incorporate the science needs and priorities of local, state, regional, and national managers, working through the regional ocean information programs described in Chapter 5.*

Each agency's first ten-year science plan should include a detailed strategy for how the proposed doubling of federal ocean research investments would be incorporated into new and ongoing activities.

The Need for Social and Economic Research

The ocean and coastal environment is rife with conflicts among competing users and between groups of people applying different sets of values to the same issues. To resolve these conflicts, information is needed not only about the natural environment but also about relevant social, cultural, and economic factors. The funding required to increase knowledge in these areas is modest when compared to the cost of the ships, labs, and instruments used in oceanographic research. Nevertheless, social and economic research related to our coasts and oceans has long been overlooked.

A Neglected Research Area

The National Sea Grant College Program does fund some studies that examine legal, political, economic, anthropological, and other human dimensions of ocean and coastal affairs. However, these projects often receive less than 10 percent of the program's overall research budget. In other research programs, social and economic science garners even less support, creating a situation where basic information is not available to support management and planning.

To meet specific programmatic requirements of the National Environmental Policy Act (NEPA) and other laws that require impact analyses, individual resource management agencies have had to pull together social science and economic information at various times. For example, NOAA's National Marine Fisheries Service hired anthropologists and economic researchers following enactment of the 1976 Magnuson–Stevens Fishery Conservation and Management Act. The Minerals Management Service instituted a socioeconomic research program in the 1970s to aid in developing five-year leasing plans that would meet NEPA standards. The U.S. Army Corps of Engineers has also funded research into marine cultural heritage to meet its NEPA obligations. And in the 1990s, NOAA's National Ocean Service created the Coastal Services Center to help generate information on coastal demographics. Although wide-ranging, these efforts remain ad hoc, uncoordinated, and related to specific issues that wax and wane in importance over time. Furthermore, the data developed on an agency-by-agency basis are often mutually incompatible and hard to access.

Recently, NOAA has begun to reassess its needs for social and economic information. In 2003, a panel of social scientists established by its Science Advisory Board concluded that NOAA's support for social sciences is not comparable to that of other agencies with similar environmental assessment and stewardship responsibilities and that this shortcoming has hindered the agency's ability to accomplish its mission.[4] NOAA's National Marine Protected Areas Center also issued a report identifying high-priority social science needs to support the planning, management, and evaluation of marine protected areas.[5]

Some existing and emerging ocean and coastal issues that will require better social and economic information include:

- multiple-use controversies in the coastal zone;
- novel offshore uses, such as the proposed introduction of offshore wind farms;
- consensus-based decision making involving stakeholders, watershed councils, public-private partnerships, and numerous nongovernmental organizations;
- changes in coastal communities due to shifts in fisheries policy, growth of the tourism industry, and redevelopment of ports and waterfronts;
- changes in coastal demographics; and
- varying perceptions of coastal environmental values.

Any decision affecting our oceans and coasts should take socioeconomic information into account, harnessing expertise from a wide range of specialties to deal with issues that demand a broad range of knowledge. This will require integrated assessments by teams of natural and social scientists working together with stakeholders and policy makers. Such an approach, which has been employed in the context of climate change, is especially well suited to emerging ocean issues that require a merger of natural and social sciences, technology, and policy.

The Coastal and Ocean Economy

Cost-benefit analyses to support ocean and coastal decisions require enhanced economic data. However, the major federal economic statistical agencies have neither the mandate nor the means to study the ocean and coastal economy.

NOAA undertakes some economic analyses in support of its various missions. For example, its Coastal and Ocean Resource Economics Program has assessed the economic impacts of fishery management plans and marine sanctuaries. NOAA has also worked with other federal agencies to conduct the first major examination of the economics of marine-related recreation.[6] But NOAA's economic analyses tend to be directed at very specific purposes associated with particular programs. NOAA has not supported sustained, consistent, and comprehensive data collection and analyses on the ocean and coastal economies.

To lay the groundwork for a broader program, NOAA and the U.S. Environmental Protection Agency are helping support the National Ocean Economics Project, a multi-year research initiative involving economists from several universities. While this effort is generating valuable information, including much of the economic data used in this report, it remains a research project. To be useful in understanding coastal and ocean economies and assessing the impacts of management policies on individuals, businesses and communities, a long-term, operational program is needed. Coordination between the federal government and other entities will be needed to generate the socioeconomic data required for operational activities (Table 25.3). NOAA, as the federal agency with principal responsibility for the oceans, should take the lead in bringing these parties together to provide the economic data needed for ocean and coastal decision making at the federal, state, regional, and local levels

Table 25.3. Organizations with Important Roles in Collecting and Distributing Socioeconomic Data on the Ocean and Coasts
The organizations listed below will play key roles in creating an operational coastal and ocean economics program to support management activities.

Entity	Role
National Oceanic and Atmospheric Administration	Current economic activities are performed by the National Marine Fisheries Service to help draft and defend Fishery Management Plans and by the Coastal and Ocean Resource Economics (CORE) Program, which conducts individual studies on issues of interest, such as economic valuations of beaches or coral reefs.
Bureau of Labor Statistics	In cooperation with the states, the Bureau collects the largest amount of basic employment and wage data on the U.S. economy. These data will continue to be the fundamental elements used for monitoring the coastal and ocean economies at national, regional, and local levels.
Bureau of the Census	The Census Bureau is the other major collector of primary data on the economy, including the tabulation of population, housing and major economic sectors.
U.S. Department of Agriculture	USDA has responsibility for the Census of Agriculture, which includes data on aquaculture.
Bureau of Economic Analysis	BEA uses inputs from the data-collecting agencies to maintain the most important measure of annual economic activity: the national income and product accounts, whose best-known element is the gross domestic product. Related measures, such as the gross state product, are key to understanding regional economies, as is the measurement of self-employment.
U.S. Environmental Protection Agency	EPA undertakes substantial economic research in the fields of land, water, and air pollution. EPA's economic research focuses particular attention on nonmarket values, and provides an important supplement to the National Oceanic and Atmospheric Administration's work in this area.
National Science Foundation	NSF supports much of the basic research in the sciences, including the social sciences. It has recently undertaken new initiatives to better integrate the natural and social sciences to improve management of the environment and natural resources.
Bureau of Transportation Statistics	BTS collects and analyzes data relative to maritime trade and transportation, such as tonnage of U.S. commerce shipped, and foreign vessel entries and departures at major U.S. ports.
Universities and Other Researchers	As with marine science in general, the majority of research on the coastal and ocean economies is a cooperative arrangement among the federal government and researchers in the nation's universities and private research organizations. The interaction among federal, academic, and private researchers benefits from the strengths of multiple perspectives and organizational missions.

Key functions of an operational program for ocean economic data should include:

- *Data Collection*—Standard measures of employment, income, and output for ocean and coastal economies must be developed. The National Ocean Economics Project provides a foundation for this work, but additional measures are needed to assess: the influence of oceans and coasts on land values; the role of the oceans in the tourism and recreation industries in terms of both market and non-market values; and the economic value of ecosystem services provided by the oceans and coasts.

- *Data Distribution*—Data must be easily accessible to policy makers to assist in management decisions and to scientists to facilitate further research. The availability of modern database and Internet delivery systems has made this function much easier and cheaper than in the past.

- *Data Analysis*—Data only become useful outside the academic realm when they are analyzed and transformed into information products. Data analyses should be tailored to federal, regional, state, and local needs. Socioeconomic trends should be analyzed and linked to environmental trends. Geographic Information Systems will facilitate the integration of socioeconomic and natural resource data.

- *Education and Research*— Additional research should focus on improving measurements of nonmarket values, developing ways to quantify the use of ocean and coastal resources, and standardizing measures such as employment and output. The field of ocean and coastal economics is relatively new and primarily confined to a small group of specialists. To accommodate the growing demand for expertise in this field, expanded training of scientists and policy specialists will be required.

Recommendation 25–3. The National Ocean Council should create a national program for social science and economic research to examine the human dimensions and economic value of the nation's oceans and coasts. All ocean research agencies should include socioeconomic research as part of their efforts.

Implementation of the national program should include:

- *designation of an operational socioeconomic research and assessment function within the National Oceanic and Atmospheric Administration (NOAA).*
- *creation of an interagency group, chaired by NOAA, and including the Bureau of Labor Statistics (BLS), Bureau of the Census, Bureau of Economic Analysis (BEA), U.S. Department of Agriculture, U.S. Environmental Protection Agency, and National Science Foundation.*
- *preparation of biennial reports by BLS and BEA on the employment, wages, and output associated with U.S. coasts and oceans.*
- *preparation of biennial reports by the Bureau of Transportation Statistics on intermodal access to U.S. ports and maritime facilities and assessments of relevant maritime system performance and economic data.*
- *support for periodic reports on such topics as coastal demographics, geographic patterns and trends of ocean and coastal use, economic contributions, attitudes and perceptions, functioning of governance arrangements, and public–private partnerships.*
- *coordination of efforts to take maximum advantage of the expertise resident within government agencies, universities, and the private sector.*
- *creation of formal mechanisms for interacting with the regional ocean information programs so that changes at regional, state, and local levels can be documented and analyzed.*

Funding for these efforts should be at least \$8–\$10 million a year. While this amount may seem substantial in a time of scarce budgetary resources, it is less than one-tenth the amount the federal government currently spends on economic research related to agriculture, although the ocean economy is 2.5 times larger than agriculture in terms of total production of goods and services (Appendix C).

Building a National Ocean Exploration Program

Ocean exploration missions conducted during the 19th and 20th centuries were the first attempts to document how deep the oceans are, to chart key bathymetric features, and to identify and study marine life. Previously, the oceans were viewed as mere highways for maritime commerce, void of life below 1,000 feet. But despite the important discoveries made during these missions, we still have only a cursory understanding of the deep ocean.

The Value of Ocean Exploration

About 95 percent of the ocean floor remains unexplored, much of it located in harsh environments such as the polar latitudes and the Southern Ocean. Experience teaches us, however, that these vast and remote regions teem with undiscovered species and resources. On virtually every expedition, oceanographers discover fascinating new creatures. Some, such as the giant squid, have never been seen alive and are known only from dead specimens washed ashore or snagged in fishing gear.

Advances in deep-sea technologies have also made it easier to locate shipwrecks and historical artifacts lost in the ocean depths, such as the stunning discovery of the *RMS Titanic* in 1985. The continued exploration of marine archaeological sites will help us to better understand human history and our global cultural heritage.

In addition, preliminary evidence indicates that immense new energy sources exist in the deep sea. The amount of carbon bound in frozen gas hydrates on the seafloor is conservatively estimated to be twice the total amount of carbon existing in all the other known fossil fuels on Earth.[7]

Ocean exploration also offers an unprecedented opportunity to engage the general public in marine science and conservation. Exploration missions to the depths of the ocean provide images of ancient human artifacts, amazing creatures, and never-before-seen ecosystems. These images fire the imagination of people of all ages and can be used in both formal and informal educational settings. This kind of popular excitement and support can be an enormous asset in sustaining exploration projects over the long term.

Given the importance of the ocean in human history and in regulating climate change, guaranteeing food security, providing energy resources, and enabling worldwide commerce, it is astounding that we still know so little about it. This is due primarily to the lack of a long-term, large-scale national commitment to ocean exploration. The ocean and its depths need to be systematically explored to serve the interests of the nation and humankind.

Growing Calls for a National Program

Although our dependence on healthy marine ecosystems continues to grow, ocean exploration remains a relatively minor component of U.S. ocean science and is a missing link in the national strategy to better understand Earth's environment. Comprehending the genetic diversity of ocean life, developing fisheries, discovering energy resources, and mapping the seafloor all require more extensive exploration. U.S. leadership in ocean exploration will increase what we know about all aspects of ocean life and resources and make it possible to reach management decisions based on more complete scientific information.

There have been many calls for a dedicated national ocean exploration program. The Stratton Commission recommended an international program on a global scale.[8] In response, the United States led the International Decade of Ocean Exploration (IDOE) in the 1970s. IDOE programs greatly improved ocean observation systems, and led to such important research programs as Geochemical Ocean Sections, the Joint Global Ocean Flux Study, the Ridge Interdisciplinary Global Experiments, and the World Ocean Circulation Experiment. These initiatives dramatically enhanced our understanding of the global climate system, geochemical cycling, ocean circulation, plate geodynamics, and life in extreme environments.

In 1983, President Reagan directed the U.S. Department of the Interior to take the lead role in exploring the waters of the newly-recognized U.S. exclusive economic zone (EEZ). Three years later, in a report to the President and Congress, the National Advisory Committee on Oceans and Atmosphere (NACOA) detailed the economic importance of the EEZ and emphasized the need to improve efforts to assess its resources.[9] The NACOA report recognized that federal science programs were making important contributions, but concluded that individual efforts based on separate agency missions were neither comprehensive nor making acceptable progress. In response, the U.S. Geological Survey (USGS) and NOAA were tasked with developing a ten-year exploration plan. Although reconnaissance surveys of much of the EEZ were completed through 1990, more detailed assessments were never pursued. During the late 1990s, efforts to explore the EEZ and beyond lagged due to budgetary constraints.

In 2000, however, the President's Panel on Ocean Exploration called for a robust national ocean exploration program propelled by the spirit of discovery. The panel proposed multidisciplinary expeditions and annual funding of $75 million.[10] These recommendations led to the establishment of the Office of Exploration within NOAA, at a modest funding level of $4 million in fiscal year 2001, and $14 million in each of fiscal years 2002 and 2003. This program is helping NOAA to fulfill its applied science, environmental assessment, and technology development responsibilities, although the program's small budget and agency-specific focus limit its effectiveness.

A 2003 National Research Council report reiterated the need for a comprehensive national ocean exploration program strongly linked to traditional research, with broad international partnerships, and a commitment to educational opportunities.[11] The report offered specific recommendations on exploration priorities, funding needs, management models, and technology and infrastructure requirements.

NOAA and the National Science Foundation (NSF), by virtue of their missions and mandates, are well positioned to lead a global U.S. ocean exploration effort. NOAA currently runs the Office of Ocean Exploration, but NSF's focus on basic research provides an excellent complement to NOAA's more applied mission. Working together, the two agencies have the capacity to systematically explore and conduct research in previously unexamined ocean environments. To succeed, coordination, joint funding, and interactions with academia and industry will be essential.

Recommendation 25–4. Congress should appropriate significant funding for an expanded national ocean exploration program. The National Oceanic and Atmospheric Administration and the National Science Foundation should be designated as the lead agencies, with additional involvement from the U.S. Geological Survey and the U.S. Navy's Office of Naval Research. Public outreach and education should be integral components of the program.

An expanded national ocean exploration program will require a budget of approximately $110 million annually, plus additional funds for required infrastructure (discussed in Chapter 27).

COORDINATING AND CONSOLIDATING MARINE OPERATIONS

The need for routine mapping, monitoring, and assessment of U.S. waters (referred to as marine operations) has grown significantly in the past two decades. Accurate, up-to-date maps and charts of harbors, coastlines, and the open ocean are necessary for many activities, including shipping, military operations, and scientific research. In addition, expanded regulatory regimes rely heavily on routine assessments of living and nonliving marine resources and water quality. However, the ocean environment is changing faster than can be documented by the current number and frequency of surveys.

Modern sensor technologies, which can detect new variables in greater detail in the water column and seafloor, have improved our ability to follow changing ocean and terrestrial dynamics. But as these new technologies are implemented, they need to be calibrated against previous methods, as well as with each other, to provide useful environmental characterizations and ensure the consistency of long-term statistical data sets.

Integrated National Maps and Assessments

At least ten federal agencies, almost all coastal states, and many local agencies, academic institutions, and private companies are involved in mapping, charting, and assessing living and nonliving resources in U.S. waters. However, different organizations use varying methods for collecting and presenting these data, leading to disparate products that contain gaps in the information they present.

Primary Federal Agencies that Conduct Science-based Marine Operations	
U.S. Environmental Protection Agency	U.S. Coast Guard
Minerals Management Service	U.S. Fish and Wildlife Service
National Geospatial-Intelligence Agency	U.S. Geological Survey
National Oceanic and Atmospheric Administration	U.S. Navy
U.S. Army Corps of Engineers	National Science Foundation

Ideally, a variety of information (e.g., bathymetry, topography, bottom type, habitat, salinity, vulnerability) should be integrated into maps using Global Positioning System coordinates and a common geodetic reference frame. In addition, these maps should include living marine resources, energy resources, and environmental data when available, to create complete ocean characterizations necessary for developing and implementing science-based ecosystem-based management approaches. Achieving this integration in the coastal zone is an extremely complex proposition.

By launching the Geospatial One-Stop Portal, the Office of Management and Budget has taken steps to curtail the collection of redundant data, facilitate information sharing, and plan for future integrated mapping and charting. This Web-based server will provide national base maps with administrative and political boundaries that can also incorporate information on agriculture, atmosphere and climate, ecology, economics, conservation, human health, inland water resources, oceans, estuaries, transportation networks, and utilities. In addition, the Federal Geographic Data Committee is developing the National Spatial Data Infrastructure in cooperation with organizations from state, local, and tribal governments, the academic community, and the private sector. This initiative includes policies, standards, and procedures for organizations to cooperatively produce and share geographically-linked data.

The relevant federal agencies must continue to integrate and share data in the quest to create readily accessible maps that track geological, physical, biological, and chemical resources in three dimensions. The fourth dimension—time—should be incorporated wherever possible so changes in ocean resources can be tracked over the short and long terms.

The National Research Council's 2003 study of national needs for coastal mapping and charting includes an examination of the major spatial information requirements of federal agencies and the principal user groups they support, identifies the highest priorities, and evaluates the potential for meeting those needs based on the current level of effort.[12]

Federal Mapping and Charting Activities

Maps of coastal land areas, and charts of nearshore and offshore areas, are essential for safe navigation and for defining boundaries, mitigating hazards, tracking environmental changes, and monitoring uses. Because so many federal agencies have mapping and charting responsibilities (Appendix 5), there are significant overlaps. This situation results in multiple entities within government, industry, and academia undertaking the expensive and time-consuming task of repeating surveys of the same area for different purposes. Furthermore, differences in scale, resolution, projection, and reference frames inhibit the integration of onshore and offshore data. It is impossible to merge most existing maps and charts to provide a continuous picture of the coastal zone. However, recent advances in the development of satellite positioning systems, mapping sensors, and the manipulation of data have created a new generation of geospatial data products that address some of the key challenges faced by ocean and coastal managers and policymakers.

The U.S. marine transportation system is in particular need of better charts. As this industry prepares for exponential growth over the next twenty years, a backlog of required surveys is developing. Approximately 35,000 square nautical miles of navigationally significant U.S. waters have been designated as critical areas requiring updated information on depth and obstructions.[13] New maps and charts of these waters and ports are essential to minimize shipping accidents and to support the national security missions of the U.S. Navy and U.S. Coast Guard.

Another significant issue is the need to conduct extensive multi-beam sonar mapping of the U.S. continental shelf, where a potential $1.3 trillion in resources (including oil, minerals, and sedentary species) could become available under United Nations Convention on the Law of the Sea (LOS Convention) provisions concerning extensions of the continental shelf. If the United States accedes to the LOS Convention, it would be able to present evidence to the United Nations Commission on the Limits of the Continental Shelf in support of U.S. jurisdictional claims to its continental shelf. The University of New Hampshire's Center for Coastal and Ocean Mapping/Joint Hydrographic Center, in conjunction with NOAA and USGS, has already identified regions in U.S. waters where the continental shelf is likely to extend beyond 200 nautical miles and is developing strategies for surveying these areas.[14] Bathymetric and seismic data will be required to establish and meet a range of other environmental, geologic, engineering, and resource needs.

Consolidation and coordination of the many existing federal mapping activities will increase efficiency and help ensure that all necessary surveys are conducted. NOAA, which has responsibility for collecting hydrographic and bathymetric data and creating navigational charts for safe and efficient maritime commerce, is the logical agency to lead the nation's coastal and ocean mapping and charting activities. Where consolidation is not feasible because of another agency's mission needs, clearer definitions of roles and responsibilities will be helpful. Drawing upon the mapping and charting abilities found in the private sector and academia will also be necessary to achieve the best results at the lowest cost.

Recommendation 25–5. The National Ocean Council (NOC) should coordinate federal resource assessment, mapping, and charting activities with the goal of creating standardized, easily accessible national maps that incorporate living and nonliving marine resource data along with bathymetry, topography, and other natural features.

In addition, the NOC should:

- *review and make recommendations on consolidation of appropriate federal, nonmilitary ocean mapping and charting activities within a strengthened National Oceanic and Atmospheric Administration.*
- *ensure that federal mapping and charting activities take full advantage of resources available in the academic and private sectors.*

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CHAPTER 26: ACHIEVING A SUSTAINED, INTEGRATED OCEAN OBSERVING SYSTEM

Coastal and ocean observations provide critical information for protecting human lives and property from marine hazards, enhancing national and homeland security, predicting global climate change, improving ocean health, and providing for the protection, sustainable use, and enjoyment of ocean resources. While the technology currently exists to integrate data gathered from a variety of sensors deployed on buoys, gliders, ships, and satellites, the implementation of a sustained national Integrated Ocean Observation System (IOOS) is overdue and should begin immediately. Care should be taken to ensure that user needs are incorporated into planning and that the data collected by the IOOS are turned into information products and forecasts that benefit the nation. In addition, the IOOS should be coordinated with other national and international environmental observing systems to enhance our Earth observing capabilities and enable us to better understand and respond to the interactions among ocean, atmospheric, and terrestrial processes.

MAKING THE CASE FOR AN INTEGRATED OCEAN OBSERVING SYSTEM

About 150 years ago, this nation set out to create a comprehensive weather forecasting and warning network and today most people cannot imagine living without constantly updated weather reports. Virtually every segment of U.S. society depends on the weather observing network. Millions of citizens check reports each day to decide how to dress, whether to plan outdoor activities, and to determine if they need to prepare for severe weather. Commercial interests use daily and seasonal forecasts to plan business activities and to safeguard employees and infrastructure. Government agencies use forecasts to prepare for and respond to severe weather, issue warnings to the general public, and decide whether to activate emergency plans.

Recognizing the enormous national benefits that have accrued from the weather observing network, it is time to invest in a similar observational and forecasting capability for the oceans. This system would gather information on physical, geological, chemical, and biological parameters for the oceans and coasts, conditions that affect—and are affected by—humans and their activities. The United States currently has the scientific and technological capacity to develop a sustained, national Integrated Ocean Observing System (IOOS) that will support and enhance the nation's efforts for:

- improving the health of our coasts and oceans;
- protecting human lives and livelihoods from marine hazards;
- supporting national defense and homeland security efforts;
- understanding human-induced and naturally caused environmental changes and the interactions between them;
- measuring, explaining, and predicting environmental changes;
- providing for the sustainable use, protection, and enjoyment of ocean resources;
- providing a scientific basis for implementation and refinement of ecosystem-based management;

- educating the public about the role and importance of the oceans in daily life;
- tracking and understanding climate change and the ocean's role in it; and
- supplying important information to ocean-related businesses such as marine transportation, aquaculture, fisheries, and offshore energy production.

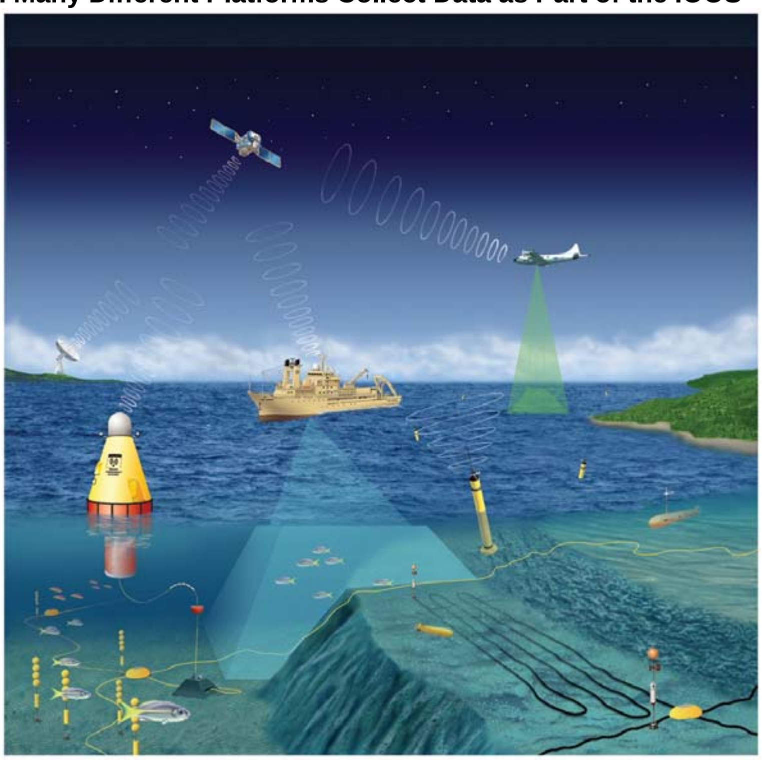
The United States simply cannot provide the economic, environmental, and security benefits listed above, achieve new levels of understanding and predictive capability, or generate the information needed by a wide range of users, without implementing the IOOS.

Components of an Integrated Ocean Observing System

The IOOS, an integrated and sustained ocean and coastal observing and prediction system, is a complex amalgam of many different land-, water-, air- and space-based facilities and technologies (Figure 26.1). Some broad categories of components are:

- *platforms,* such as ships, airplanes, satellites, buoys, and drifters, that are used for mounting or deploying instruments, sensors, and other components;
- *instruments and sensors* that sample, detect, and measure environmental variables;
- *telecommunication systems* that receive and transmit the data collected by the instruments and sensors; and
- *computer systems* that collect, store, assimilate, analyze, and model the environmental data and generate information products.

Figure 26.1. Many Different Platforms Collect Data as Part of the IOOS



This picture is an artist's rendering of the various water-, air-, and space-components of ocean observing systems. The data collected by each of these different sensors are transmitted via seafloor fiber optic cables and satellites to a central location on land.
Picture courtesy of the Marine Technology Society, Columbia, MD.

Assessing Existing Observing Systems

The United States has numerous research and operational observing systems that measure and monitor a wide range of terrestrial, atmospheric, and oceanic environmental variables (Appendix 5). For the most part, each system focuses on specific research objectives or limited operational applications. Among these are the U.S. Geological Survey's (USGS's) stream gage monitoring system that helps predict flooding and droughts, the National Weather Service's atmospheric observation system for weather, wind, and storm predictions and warnings, and the USGS/National Aeronautics and Space Administration (NASA) Landsat satellite system that characterizes landscape features and changes for land use planning. The technologies used run the gamut from simple on-the-ground human observations to highly sophisticated instruments, such as radar, radiometers, seismometers, magnetometers, and multispectral scanners.

Coastal and Ocean Observing Systems

Currently, the United States has more than forty coastal ocean observing systems, operated independently or jointly by various federal, state, industry, and academic entities (Appendix 5). The federal government also operates or participates in several large-scale, open-ocean observing systems. Examples include the National Oceanic and Atmospheric Administration's (NOAA's) Tropical Atmosphere Ocean program in the central Pacific Ocean that provides data to monitor and predict El Niño–La Niña conditions and the global-scale Argo float program for monitoring ocean climate.

There are several independent regional ocean and coastal observing systems. For the most part, they were built for different purposes and applications, measure different variables at different spatial and temporal scales, are not intercalibrated, and use different standards and protocols for collecting, archiving, and assimilating data. They also compete with each other for the limited funding available to support such efforts. As a result, despite considerable interest among stakeholders, and existence of required technology and scientific expertise, the United States has progressed very slowly in the design and implementation of a cohesive national ocean observing system.

An integrated ocean and coastal observing system that is regionally, nationally, and internationally coordinated and is relevant at local to global scales can serve a wide array of users, be more cost-effective, and provide greater national benefits relative to the investments made. Although the current regional systems are valuable assets that will be essential to the implementation of the IOOS, they are insufficiently integrated to realize a national vision.

Committing to Creation of the IOOS

The global ocean community has consistently articulated the need for a sustained ocean observing system to address the myriad challenges facing the world's oceans. In 1991, the United Nations Intergovernmental Oceanographic Commission proposed implementation of the Global Ocean Observing System (GOOS), and in 1992 participating nations at the United Nations Conference on Environment and Development (known as the Earth Summit) in Rio de Janeiro agreed to work toward establishment of this global system.

The U.S. National Ocean Research Leadership Council (NORLC), the leadership body for the National Oceanographic Partnership Program, has taken the lead in creating the IOOS, which will serve in part as the U.S. contribution to the GOOS. In response to congressional requests, the NORLC drafted two reports outlining the steps for creating a national system: *Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System (1999)*, and *An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of a U.S. Plan (2000)*. The second report provided a blueprint for the system's design and implementation. In October 2000, the NORLC established a federal interagency office called Ocean.US and charged it with coordinating development of the IOOS.

Ocean.US has made significant progress on a strategic plan for design and implementation. The plan is based on two distinct components: open ocean observations conducted in cooperation with the international GOOS and a national network of coastal observations conducted at the regional level. The coastal component will include the U.S. exclusive economic zone, the Great Lakes, and coastal and estuarine areas.

Developers of the IOOS must ensure that the global component is not minimized and that the connectivity with GOOS, including U.S. funding and leadership, remains strong and viable. GOOS data will be essential for assimilating environmental data that spans many spatial scales and for creating forecasts of national and regional impacts that may originate hundreds or thousands of miles away. Strong U.S. involvement in the GOOS will also demonstrate the nation's commitment to working toward an inclusive Earth observing system.

Although many individuals and agencies have spent countless hours creating plans for the IOOS, its successful realization will require high-level visibility and support within the administration, Congress, and the broad stakeholder community.

Recommendation 26–1. The National Ocean Council should make development and implementation of a sustained, national Integrated Ocean Observing System a central focus of its leadership and coordination role.

The support of a broad-based, multi-sector constituency is also critical to the success of the IOOS, particularly in light of the funding levels required to build, operate, and sustain such as system. As a first step, two national pilot projects and one or two international pilot projects should be implemented to link existing systems and produce operational applications relevant to national policy and a broad spectrum of users. The pilot projects will provide important visibility and demonstrate the potential economic and societal benefits of the full system, while advancing research and development of useful technologies and applications.

CREATING A GOVERNANCE STRUCTURE FOR THE IOOS

National Planning

A strong national governance structure is required to establish policy and provide oversight for all components of the IOOS and to ensure strong integration among the regional, national, and global levels. Interagency coordination and consensus through the National Ocean Council and Ocean.US will be essential. While regional systems will retain a level of autonomy, achievement of the IOOS with nationwide benefits will require the regional systems to follow some national guidelines and standards. (Chapter 5 includes additional discussion of regional observing systems and their place within broader regional ocean information programs.) Regional observing systems can and should pursue needs outside the scope of the national system so long as these activities do not conflict with the smooth operation of the IOOS.

NOAA's role as the nation's civilian oceanic and atmospheric agency, and its mission to describe and predict changes in the Earth's environment and to conserve and manage the nation's coastal and marine resources, make it the logical federal agency to implement and operate the national IOOS.

Recommendation 26–2. Ocean.US, with National Ocean Council (NOC) oversight, should be responsible for planning the national Integrated Ocean Observing System (IOOS). The National Oceanic and Atmospheric Administration should be the lead federal agency for implementing and operating the IOOS, with extensive interagency coordination and subject to NOC approval.

Ocean.US

A memorandum of agreement (MOA) among ten federal agencies created Ocean.US as an interagency ocean observation office, supported by annual contributions from the signatories. The fundamental problem with the current arrangement is that Ocean.US has a number of responsibilities without any real authority or control over budgets. Its ephemeral existence under the MOA, its dependence on personnel detailed from the member agencies, and its lack of a dedicated budget severely detract from its stature within the ocean community and its ability to carry out its responsibilities.

Signatories to the Ocean.US Memorandum of Agreement	
U.S. Navy	Minerals Management Service
National Oceanic and Atmospheric Administration	U.S. Department of Energy
National Science Foundation	U.S. Coast Guard
National Aeronautics and Space Administration	U.S. Army Corps of Engineers
U.S. Geological Survey	U.S. Environmental Protection Agency

A more formal establishment of the Ocean.US office is needed for it to advise the National Ocean Council and achieve its coordination and planning mandates. The office requires consistent funding and dedicated full-time staff with the expertise and skills needed to ensure professional credibility. In addition, outside experts on rotational appointments could help Ocean.US meet its responsibilities.

Recommendation 26–3. Congress should amend the National Oceanographic Partnership Act to formally establish Ocean.US, with a budget appropriate to carry out its mission. Ocean.US should report to the National Ocean Council's (NOC's) Committee on Ocean Science, Education, Technology, and Operations (COSETO).

Congress should:

- *make the Ocean.US budget a line item within the National Oceanic and Atmospheric Administration's budget, to be spent subject to NOC approval.*
- *give Ocean.US authority to bring in outside experts on rotational appointments when needed.*

Regional Structure

Ocean.US envisions the creation of a nationwide network of regional ocean observing systems that will form the backbone of coastal observations for the IOOS. Although Ocean.US proposes creation of regional associations for coastal observing, coordinated through a national federation, [1,2] this concept is unnecessarily narrow. To fully address the needs of coastal managers, ocean observations need to be integrated into other information gathering activities such as regionally-focused research, outreach and education, and regional ecosystem assessments. Thus, as recommended in Chapter 5, the regional ocean information programs should be in charge of the development and implementation of regional ocean observing systems, along with their broader responsibilities. Regular meetings among all the regional ocean information programs and Ocean.US will be important for providing regional and local input into the development of the national IOOS.

Reaching Out to the User Community

To fulfill its mission, the IOOS must meet the needs of a broad suite of users, including the general public. However, at this early stage many people do not even know what the national IOOS is, nor do they grasp the potential utility and value of the information it will generate. This has slowed progress in its implementation.

Some important stakeholders outside of the federal agency and ocean research communities have not been sufficiently integrated into the initial planning process. Some of those who were consulted believe they were brought into the process after important design and other decisions had already been made. While Congress and the administration have both expressed support for the concept of a national integrated ocean observing system, there has been insufficient constituent demand to compel appropriation of significant public funds. Clearer communication about the benefits of the IOOS and broader participation in planning activities are necessary to help create a groundswell of support.

To get the most out of the IOOS, resource managers at federal, state, regional, territorial, tribal, and local levels will need to supply input about their information needs and operational requirements and provide guidance on what output would be most useful. Other users, including educators, ocean and coastal industries, fishermen, and coastal citizens, must also have a visible avenue for providing input. Ocean.US and the regional ocean information programs will need to devote significant time and thought to proactively approaching users and promoting public awareness of the enormous potential of the IOOS.

One obvious application of the observing system will be to monitor potential terrorist threats to the United States, including the possible use of commercial and recreational vessels to introduce nuclear, chemical, or biological weapons through the nation's ports to attack large metropolitan areas or critical marine infrastructure. Thus, it is important that homeland security personnel be actively engaged in defining their needs as part of the IOOS design process.

Recommendation 26–4. Ocean.US should proactively seek input from coastal and ocean communities to build cross-sector support for the national Integrated Ocean Observing System (IOOS) and develop consensus about operational requirements.

Specifically, Ocean.US should seek input from:

- *state, local, territorial, and tribal management agencies, industry, academia, nongovernmental organizations, and the public in the design and implementation of regional ocean observing systems and their integration into the national IOOS.*
- *Homeland security agencies in the design of the national IOOS, including planning for future research and development efforts to improve and enhance the system.*

Assembling the Elements of a Successful IOOS

The success of the IOOS will depend on several design elements: measuring the right set of environmental variables to meet regional, national, and global information requirements; transitioning research accomplishments into operational applications; and developing technologies to improve all aspects of the system, especially the timeliness and accuracy of its predictive models and the usefulness of its information products.

Critical Environmental Variables

To establish a uniform national system, a consistent core of environmental variables must be measured by all of the system's components. This core must strike a balance, remaining manageable and affordable while including enough parameters to address watershed, atmosphere, and ocean interconnections and support resource management, research, and practical use by many stakeholders. Measurements should include natural variables as well as human influences.

Based on an evaluation of more than one hundred possible environmental variables, Ocean.US identified an initial priority set of physical, chemical, and biological parameters for measurement by the IOOS (Table 26.2). It also created a supplemental list of meteorological, terrestrial, and human variables that are related to ocean conditions (Table 26.3).[3]

Table 26.2. Proposed Core Variables for the IOOS
Participants at an Ocean.US workshop recognized the following variables as important measurements to be made by the national IOOS.

Physical	Chemical	Biological
Salinity	Contaminants: Water	Fish Species
Water Temperature	Dissolved Nutrients	Fish Abundance/Biomass
Bathymetry	Dissolved Oxygen	Zooplankton Species
Sea Level	Carbon: Total Organic	Optical Properties
Directional Wave Spectra	Contaminants: Sediments	Ocean Color
Vector Currents	Suspended Sediments	Pathogens: Water
Ice Concentration	pCO_2	Phytoplankton Species
Surface Heat Flux	Carbon: Total Inorganic	Zooplankton Abundance
Bottom Characteristics	Total Nitrogen: Water	Benthic Abundance
Seafloor Seismicity		Benthic Species
Ice Thickness		Mammals: Abundance
Sea-surface Height		Mammals: Mortality Events
		Bacterial Biomass
		Chlorophyll-a
		Non-native Species
		Phytoplankton Abundance
		Phytoplankton Productivity
		Wetlands: Spatial Extent
		Bioacoustics

Source: National Ocean Research Leadership Council. *Building Consensus: Toward an Integrated and Sustained Ocean Observing System*. Proceedings of an Ocean.US workshop. Arlington, VA, March, 2002.

Table 26.3: Proposed Supplemental IOOS Variables
In addition to the ocean specific variables listed above, the participants at the Ocean.US workshop highlighted a number of other variables that affect ocean and coastal environments.

Meteorological	Terrestrial	Human Health & Use
Wind Vector	River Discharge	Seafood Contaminants
Air Temperature	Groundwater Discharge	Pathogens: Seafood
Atmospheric Pressure		Fish Catch and Effort
Precipitation (dry and wet)		Seafood Consumption
Humidity		Beach Usage
Aerosol Type		
Ambient Noise		
Atmospheric Visibility		
Cloud Cover		

Source: National Ocean Research Leadership Council. *Building Consensus: Toward an Integrated and Sustained Ocean Observing System*. Proceedings of an Ocean.US workshop. Arlington, VA, March, 2002.

While these lists provide a starting point for further discussion, many of the items included are actually broad categories rather than specific variables to be measured. The lists do not specify which variables can be measured with current technologies, which particular contaminants and pathogens should be observed, or which sets of observations can be assimilated to predict potentially hazardous environmental conditions, such as harmful algal blooms. Surprisingly, several important variables, such as inputs of air- and river-borne pollutants, are not included at all.

These lists will require further refinement and review by potential users of the system and a mechanism must be established to solicit additional feedback. Regional observation needs, such as fish stock assessments, assessments of sensitive and critical habitats, or monitoring for invasive species, are best understood by those in the regions affected. Therefore, input from local and regional groups, organized through the regional ocean information programs, will be essential for determining which variables should be included as national priorities.

Variables should be prioritized based on their value in resolving specific issues or questions, their application across issues, and the cost of measuring them. Priorities should also be assigned based on the variable's application to global, national, regional, state, and local information needs. Future deliberations will also need to identify variables for which current observation capabilities are sufficient and those that require new technologies.

Recommendation 26–5. Ocean.US, with National Ocean Council oversight, should develop a set of core variables to be collected by all components of the national Integrated Ocean Observing System.

This set of core variables should:

- *include appropriate biological, chemical, geological, and physical variables.*
- *be agreed on by the regional ocean information programs.*

Space-based Mission Priorities

Space-borne sensors can provide comprehensive, real-time, widespread coverage of ocean conditions and features and will be an integral part of the national IOOS. A growing international constellation of satellites allows extensive observation of ocean-surface conditions as well as the ability to extrapolate measurements from *in situ* sensors. Satellites can also provide baseline measurements at local, regional, national, and global scales that can be used to assess long-term environmental changes and the impacts of catastrophic events.

However, implementing sustained observations from space requires intense planning with long lead times. Given the cost, the time frame for constructing and launching satellites, and the inability to modify satellites once in orbit, five- to ten-year plans are required to ensure that satellite observations will be available on a continuous basis and employ the most useful and modern sensors. NOAA, as the lead federal agency for implementing and operating the IOOS, must ensure that ongoing satellite operations are fully integrated into the national IOOS.

Common needs for space-based observations should be identified and prioritized by a diverse group of users, in a manner similar to that recommended for determining IOOS environmental variables. Coordination with international satellite organizations will also be necessary to integrate the national IOOS with the GOOS and to accelerate development of new satellite-based sensor technologies.

Recommendation 26–6. Ocean.US should recommend priorities and long-term plans for space-based missions as an essential component of the national Integrated Ocean Observing System.

Ocean.US should:

- *work closely with the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, the user community, and the space industry to identify the most important space-based ocean observation needs.*
- *work with the international community on technical requirements for the Global Ocean Observing System in developing a plan for satellite remote sensing.*

Converting Research into Operational Capabilities

Research Observatories

A number of research observatories now in operation were created primarily by academic institutions to develop new observation technologies. Rutgers University's Long-term Ecosystem Observatory and the Monterey Bay Aquarium Research Institute's Ocean Observing System are two examples of programs that have made significant advances in developing observation technologies and the data management systems needed to support them. These observatories provide valuable scientific and engineering information that will be essential in building the IOOS. However, they can not be easily integrated into an operational, national IOOS, which will need to be based on stable, proven technologies and structured to deliver long-term observations.

The national IOOS will also have significant synergies with the NSF Ocean Observatories Initiative, which is being designed to address the ocean research community's needs for long-term, *in situ* measurements of biological, chemical, geological, and physical variables over a variety of scales. The NSF observatories will be used to examine the processes that drive atmospheric, oceanic, and terrestrial systems, and will serve as an incubator for new technologies to monitor these processes. While the IOOS and the NSF observatories have thus far been planned independently, the basic research and technology development from the NSF Observatories and the information generated by the IOOS are in reality interdependent, with each program supplying ingredients essential to the other. Close coordination and cooperation between NOAA and NSF will be necessary to capitalize on these benefits.

To ensure that the best available science and technology are continuously integrated into the national IOOS, mechanisms are needed for transitioning findings from research settings to routine operational applications. A new NOAA Office of Technology, recommended in Chapter 27, would be instrumental in making this transfer proceed smoothly. It would oversee coordination between NOAA, NSF, the U.S. Navy (including the Office of Naval Research, Naval Research Laboratory, Naval Oceanographic Office, Fleet Numerical Meteorology and Oceanography Center, and National Ice Center), NASA, other pertinent federal agencies, academia, and the private sector, all of which are essential in creating the bridge from research to operations.

New Sensor Technology

One area where additional capabilities are critically needed is in sensor technologies. Currently, the ability to continuously observe and measure physical variables (such as water temperature, current speed, and wave height) far surpasses the ability to measure chemical and biological parameters. With a few exceptions, most chemical and biological measurements are still obtained mainly by direct sampling and analysis. This shortcoming seriously hampers real-time observations of a broad range of biological parameters and populations of special interest, such as corals, marine mammals, and fish stocks. To realize the full promise of the IOOS, accelerated research into biological and chemical sensing techniques will be needed, with rapid transitions to operational use. NOAA, NSF, the Navy, and NASA should fund the development, and subsequent integration, of biological and chemical sensors for the IOOS as high priorities. Sensor development is discussed in more detail in Chapter 27.

Recommendation 26–7. The National Oceanic and Atmospheric Administration, the National Science Foundation (NSF), the U.S. Navy, and the National Aeronautics and Space Administration should require investigators who receive federal funding related to ocean research observatories, including the NSF Ocean Observatories Initiative, to develop plans for transferring new technologies to an operational mode in the Integrated Ocean Observing System.

Consolidating Civilian Satellite Observations

Both NOAA and NASA currently operate civilian, space-based, Earth observing programs that measure terrestrial, atmospheric, and oceanic variables (Appendix 5). NOAA's primary mission in this area is to provide sustained, operational observations for monitoring and predicting environmental conditions and long-term changes, with a focus on weather and climate. In contrast, NASA's mission is to advance research efforts and sensor development. A NASA project can last from a few days to a few years, and NASA has repeatedly asserted that it is not in the business of providing data continuity. In many instances, the lifetime of a NASA satellite, and its continued ability to collect and transmit data, outlasts its funding, resulting in premature termination at odds with the pressing demands for data in the operational context.

Benefits of Consolidation

While NASA-led research missions have greatly advanced our understanding of the oceans, they are developed without regard to ongoing, operational observing needs beyond the planned one- to ten-year life of the individual mission. Thus NASA's efforts have not, and will not, result in the sustained capabilities needed for the national IOOS. NASA also does not have the extensive atmospheric, land, and ocean ground-truthing infrastructure needed to verify remote observations for operational purposes.

The integration of space-based Earth environmental observing into one agency will greatly ease the implementation of a functional national system. Development of a multi-decadal record of observations requires space missions with sufficient overlap to avoid gaps in data collection and allow intercalibration of successive generations of sensors. Lack of such coordination can result in crippling information gaps, such as occurred during an eleven-year hiatus in the collection of ocean color data between the Coastal Zone Color Scanner and SeaWiFS missions. By consolidating Earth, and particularly ocean, observing satellite missions, more seamless, long term planning will be possible, resulting in a smooth concept-to-operations data collection process.

Recommendation 26–8. Congress should transfer National Aeronautics and Space Administration's (NASA's) Earth environmental observing satellites, along with associated resources, to the National Oceanic and Atmospheric Administration (NOAA) to achieve continued operations. NOAA and NASA should work together to ensure the smooth transition of each Earth environmental observing satellite after its launch.

Specifically, NOAA should:

- *work with NASA to define requirements for research-oriented Earth observing missions.*
- *ensure that satellite-derived ocean databases are integrated with traditional ocean and coastal databases.*
- *implement phased satellite missions and equipment replacement to maintain consistent data acquisition, based on Ocean.US plans.*
- *establish a long-term archive that includes historical satellite data to safeguard records, particularly those related to climate trends.*
- *prepare budget submissions that reflect the cost of transitioning satellite research missions into sustained operation.*

Because of its expertise and capabilities, NASA should maintain research, engineering, and development responsibility for Earth observing satellites. However, operational control of these satellites should be turned over to NOAA after the integrity of the satellite is confirmed in orbit (usually within approximately twenty days). This handoff has been demonstrated with the National Polar-orbiting Operational Environmental Satellite System.

Planning for Satellite Consolidation

A number of infrastructure and organizational changes will be needed at NOAA to ensure seamless assimilation of all Earth environmental observing satellites. Enhanced science, technology, and management coordination should occur within NOAA and among NOAA, other agencies, and the private and academic sectors. In addition, NOAA should initiate a review of its past successes and challenges in remote-sensing activities, satellite hardware procurement, satellite data collection and processing, and data distribution and archival strategies and programs. It is essential that NOAA be able to deliver raw data as well as analytical products to the public on an ongoing basis, and archive data in readily accessible formats for future assessments of environmental change.

NOAA's data and information management practices should be flexible, address customer needs, allow for continuous feedback and improvement, and be based on partnerships with industry and academia when appropriate. Further recommendations for improved data management and information product development within NOAA are found in Chapter 28. NOAA will also need to plan for continued calibration of all its observing satellites, using academic and private sector partners to form calibration and validation teams.

Developing Useful End Products Based on IOOS Data

To justify large federal investments in the IOOS, the system must result in tangible benefits for a broad and diverse user community, including the general public, scientists, resource managers, emergency responders, policy makers, private industry, educators, and officials responsible for homeland security. The IOOS cannot be developed as a narrow system useful only for research or federal government applications. The longtime partnership between the National Weather Service (NWS) and the private sector, which results in both general and tailored weather forecast and warning products that are widely acknowledged as valuable, is a good model upon which to build the IOOS.

The National Weather Service: An Investment That Paid Off

Billions of dollars have been invested over the last century to create a robust weather-related observing system. Continued operation of the National Weather Service (NWS) costs every U.S. citizen $4-$5 a year. For this investment, the NWS issues more than 734,000 weather forecasts and 850,000 river and flood forecasts annually, along with 45,000–50,000 potentially life-saving severe weather warnings. These forecasts and warnings have the potential to save millions to billions of dollars. For example, during a typical hurricane season, the savings realized based on timely warnings add up to an estimated $2.5 billion.[4] Geomagnetic storm forecasts are estimated to save the North American electric generating industry upwards of $150 million per year.[5]

NWS and commercial meteorological products have applications ranging from scientific research to human safety, transportation, agriculture, and simple daily forecasts. Similarly, IOOS products should be wide-ranging and based on the needs of regional and local organizations and communities, as well as national needs. The regional ocean information programs described in Chapter 5 will help produce information products of benefit to regional, state, and local managers and organizations. These regional programs will also provide important feedback to national planners about ways to make national IOOS products more useful. In addition, close coordination with Ocean.IT (a new data management office recommended in Chapter 28) will help in developing new forecast models of coastal and open-ocean conditions.

NOAA–Navy Partnership

Both NOAA and the Navy have the computer infrastructure and human capital needed to produce data and information products at varying spatial and temporal scales, and have experience tailoring products to the requirements of stakeholders in different regions and for different purposes. A joint NOAA–Navy ocean and coastal information management and communications program can help ensure high-quality end products from the national IOOS. Working together, these agencies will be able to produce routine operational ocean condition reports, forecasts, and warning products based on data from the IOOS. The NOAA–Navy program should work closely with nonfederal organizations, such as state and local governments, the regional ocean information programs, educators, nongovernmental organizations, and the private sector, to ensure that IOOS information products are useful to a broad user community. Specific recommendations about a NOAA–Navy ocean and coastal information management and communications program are included in Chapter 28.

Table 26.4. Proposed Annual Costs for Implementation
Assuming startup in fiscal year 2006, this table shows the IOOS cost estimates for each year until 2010. These figures do not include the costs for some essential components, such as satellite observations, which could add another $50-100 million per year.

Fiscal Year	Cost
2006	$138 million (start-up costs)
2007	$260 million
2008	$385 million
2009	$480 million
2010	$500 million (fully operational system)
Total for first five years	$1.7 billion
Out Years	$500 million/yr (to keep system operational, not accounting for inflation)

Data courtesy of Ocean.US., Arlington, VA.

Funding the National IOOS

The existing IOOS implementation plan calls for a distributed funding structure under which funds for implementation and operation of the national IOOS would be appropriated to many individual ocean agencies to support their respective contributions to the system.[6] This approach is not conducive to timely and seamless implementation of the national IOOS. The differences in missions and priorities among the ocean agencies could slow the implementation of key components of the IOOS. Additionally, the federal ocean agencies answer to different congressional committees and subcommittees for authorizations and appropriations, which could result in inconsistent and incomplete funding of the national system. Furthermore, in times of tight budgets, federal agencies may be tempted to tap into their IOOS budgets to support other shortfalls or unfunded initiatives. Only by consolidating the IOOS budget within one agency, with input and agreement on spending from the other agencies, can full implementation be assured.

System Cost Estimates

Ocean.US has provided estimates of the costs of implementing, operating, maintaining, and enhancing a national IOOS. The plan for the system involves a four-year ramp-up of funding, from a $138 million start-up cost in fiscal year 2006 to $500 million annually starting in fiscal year 2010 (Table 26.4). Details of the $138 million start-up cost are provided in Table 26.5.[7] The cumulative cost over the first five years is estimated at $1.7 billion.

Table 26.5: Breakdown of Proposed IOOS Start-up Costs
In fiscal year 2006, the start-up cost of $138 million is based on expenditures for four distinct components.

Activity	Cost to Perform
Accelerate the implementation of the U.S. commitment to the Global Ocean Observing System	$30M
Develop data communications and data management systems for the national IOOS	$18M
Enhance and expand existing federal observing programs	$40M
Develop regional observing systems	$50M
Total	**$138M**

Source: Ocean.US. *An Integrated and Sustained Ocean Observing System (IOOS) for the United States: Design and Implementation*. Arlington, VA, May 2002.

However, these cost estimates are not complete. They do not include all requirements for building, operating, and maintaining the system, such as costs associated with dedicated satellite sensors, space-borne platforms, and data stream collection and assimilation. Considering these additional system elements, rough estimates suggest that total funding for the national IOOS over the first five years may be closer to $2 billion.

Continuous improvements to IOOS observation and prediction capabilities will require sustained investments in technology development. Considering the costs of sensor development, telecommunications, computer systems, and improvements in modeling and prediction capabilities, an additional annual investment of about $100–$150 million will most likely be needed. Thus, the eventual ongoing costs for operating, maintaining, and upgrading the national IOOS could approach $650–$750 million a year.

Given the importance of the IOOS as an element in an integrated Earth observing system, these costs are in line with federal expenditures for other elements, including atmospheric, hydrologic, and pollution-related monitoring. For example, the ongoing cost of operating NWS is a comparable $700 million a year.

To fulfill its potential, the IOOS will require stable funding over the long haul. The lack of long-term funding for existing regional ocean observing systems has contributed to their isolation and piecemeal implementation. Consistent funding will help ensure that the American public receives the greatest return for its investment in the form of useful information, reliable forecasts, and timely warnings.

Recommendation 26–9. Congress should fund the Integrated Ocean Observing System (IOOS) as a line item in the National Oceanic and Atmospheric Administration (NOAA) budget, to be spent subject to National Ocean Council direction and approval. IOOS funds should be appropriated without fiscal year limitation. NOAA should develop a streamlined process for distributing IOOS funds to other federal and nonfederal partners.

An Investment with Big Returns: The Economic Value of Ocean Observations

While it is impossible to predict all the economic benefits that would flow from a national Integrated Ocean Observing System, its potential can be estimated by looking at a few systems currently in operation.

For example, the Tropical Global Ocean Atmosphere (TOGA) observing system in the Pacific Ocean provides enhanced El Niño forecasting. The economic benefits of these forecasts to U.S. agriculture have been estimated at $300 million per year.[8] Advanced El Niño forecasts allow fishery managers to adjust harvest levels and hatchery production 12 to 16 months in advance. For one small northwestern Coho salmon fishery, the net benefits of these forecasts have been estimated to exceed $1 million per year.[9] When summed over all economic sectors, the estimated value of improved El Niño forecasts reaches $1 billion a year.[10]

Improved wind and wave models based on ocean observations make weather-based vessel routing possible. Today, at least half of all commercial ocean transits take advantage of this, saving $300 million in transportation costs annually.[11] Search and rescue efforts by the U.S. Coast Guard also benefit from ocean observations. Small improvements in search efficiency can generate life and property savings in excess of $100 million per year.[12] Although more difficult to quantify, marine tourism, recreation, and resource management also benefit greatly from integrated observations and the improved forecasts they allow.

Finally, scientists estimate that reductions in greenhouse gas emissions now, compared to 20 years in the future, could result in world-wide benefits of $80 billion, with the United States' share approaching $20 billion.[13] Such emissions reductions will only be undertaken when policy makers feel fairly certain about their likelihood of success. Improved ocean observations and models will be critical to filling these knowledge gaps to support appropriate action.

STRENGTHENING EARTH OBSERVATIONS THROUGH NATIONAL AND INTERNATIONAL PARTNERSHIPS

Other U.S. Operational Observing Systems

Atmospheric, terrestrial, and oceanic conditions and processes are inextricably intertwined. Progress in managing and protecting global resources will depend on understanding how those systems interact and what their impacts are on all scales, from local to global, over minutes or decades. Understanding such interactions is essential for accurately forecasting global climate change (long-term or abrupt), seasonal to decadal oscillations (like El Niño–La Niña, the North Atlantic Oscillation, or the Pacific Decadal Oscillation), and short and long-term ecosystem responses to environmental change.

The IOOS cannot exist as a stand-alone system, developed without considering associated observations. Rather, it should be integrated with other environmental observing systems to link weather, climate, terrestrial, biological, watershed, and ocean observations into a unified Earth Observing System. Such a system would improve understanding of environmental changes, processes, and interactions, making ecosystem-based management possible.

Integration of the IOOS with NWS's ground-, water-, space-, and atmosphere-based observations, with USGS's stream gage, water quality monitoring, and landscape observations, and with EPA's pollution monitoring, should be essential steps in implementation of the IOOS. The IOOS should also be linked with the broad national water quality monitoring network recommended in Chapter 15. Credible data gathered through other agencies and mechanisms, such as the Coral Reef and Invasive Species task forces, should all be considered in creating a coordinated Earth Observing System.

Recommendation 26–10. The National Ocean Council should oversee coordination of the Integrated Ocean Observing System with other existing and planned terrestrial, watershed, atmospheric, and biological observation and information collection systems, with the ultimate goal of developing a national Earth Observing System.

Enhancing Global Cooperation

The United States should continue to participate in the international Global Ocean Observing System to gain a better understanding of global ocean circulation patterns and biological processes, and answer pressing policy questions about global climate change and resource availability. In July 2003, the Earth Observation Summit was held in Washington, D.C. to focus on building an integrated global observation system over the next ten years. Thirty-four nations, the European Commission, and twenty international organizations joined the United States in adopting a declaration that affirmed the need for timely, high-quality, long-term global Earth observations as a basis for sound decision making. The ad hoc Group on Earth Observations has been formed to implement the declaration, co-chaired by the United States, the European Commission, Japan, and South Africa, and an implementation plan is scheduled to be completed by late 2004.

A recurring limitation of international scientific agreements and programs is the growing divide between scientific capacity and resources in developed and developing nations. Global programs function most effectively when all partners can participate fully. In addition to expanding scientific knowledge and stimulating technological development, capacity-building programs serve U.S. interests by creating goodwill and strengthening ties with other countries. Examples of capacity-building techniques include: providing access to U.S. scientific and technological expertise on a continuing basis; establishing education and training programs; securing funding for travel grants to allow scientists from less developed countries to participate in symposia, conferences, and research cruises; and funding international student fellowships.

High-level U.S. participation in international global observing planning meetings is essential, particularly by top-level NASA and NOAA officials. Furthermore, the United States should be strongly involved in international Earth Observation satellite missions. This includes supporting U.S. scientists to participate in foreign satellite mission planning and execution activities, such as planning for enhanced data management and access protocols.

Compatibility and accessibility of data collected by all participants in the GOOS will be needed to make the whole worth more than the sum of its parts. Although the United States has always supported full and open access to oceanographic data, this policy has met with resistance in some nations, especially where basic data collection and management activities have been outsourced to private companies. The U.S. should encourage foreign entities to engage in a policy of reciprocity, with a commitment to mutual sharing of data.

Recommendation 26–11. The National Ocean Council (NOC) should promote international coordination and capacity building in the field of global ocean observations.

The NOC should:

- *lead the interagency implementation of the 2003 Declaration on Earth Observing.*
- *encourage and support developing nations' participation in the Global Ocean Observing System.*
- *continue to advocate full, open, and meaningful data access policies and contribute technological expertise to ensure such access by all participants.*

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Chapter 27: Enhancing Ocean Infrastructure and Technology Development

The future success of ocean and coastal research in the United States will depend on the availability of modern ships, undersea vehicles, aircraft, laboratories, and observing systems, as well as the continuous development and integration of new technologies into these facilities. Significant interagency coordination, guided by a national strategy, is needed to plan the acquisition and operation of expensive, large-scale assets. A renewed commitment to funding the purchase, maintenance, and operation of these facilities will be essential. Technology development activities would be further aided by creating virtual centers of marine technology with coordinated federal activities to help transition new technologies into operational use.

Advancing Ocean and Coastal Science with Modern Tools

A robust infrastructure with cutting-edge technology forms the backbone of modern ocean science. It supports scientific discovery and facilitates application of those discoveries to the management of ocean resources. The nation has long relied on technological innovation, including satellites, early-warning systems, broadband telecommunications, and pollution control devices to advance economic prosperity, protect life and property, and conserve natural resources. Ocean research, exploration, mapping, and assessment activities will continue to rely on modern facilities and new technologies to acquire data in the open ocean, along the coasts, in challenging polar regions, on the seafloor, and even from space.

The three major components of the nation's scientific infrastructure for oceans and coasts are:
- *Facilities*—land-based laboratories and ocean platforms, including ships, airplanes, satellites, and submersibles, where research and observations are conducted;
- *Hardware*—research equipment, instrumentation, sensors, and information technology systems used in the facilities; and
- *Technical Support*—the expert human resources needed to operate and maintain the facilities and hardware as well as participating in data collection, assimilation, analysis, modeling, and dissemination.

This chapter does not attempt to provide a comprehensive review of all marine-related infrastructure and technology needs. Rather, it highlights several key areas where improvements in federal planning, coordination, and investment will be essential to support an enhanced ocean science enterprise.

Improving Infrastructure and Technology

Gaps in Infrastructure

Periodic surveys have attempted to assess various aspects of academic, private-sector, and federal ocean infrastructure, but many of these attempts have been incomplete, particularly regarding private and academic assets. The last official inventory of marine facilities, undertaken in 1981 by the Congressional Office of Technology Assessment, did not include information related to maritime commerce, marine safety, or education.[1]

As one of its early tasks, the U.S. Commission on Ocean Policy, as required by the Oceans Act of 2000, authorized an extensive assessment of the infrastructure associated with ocean and coastal activities (Appendix 5). This inventory documents the U.S. infrastructure for maritime commerce and transportation, ocean and coastal safety and protection, research, exploration, and monitoring, and marine education and outreach. The number and types of assets included are extensive and cover a wide range of federal, state, academic, institutional, and private-sector entities. Together, they represent a substantial public and private investment that has made possible great strides in modern oceanography over the last fifty years. But the assessment also revealed that significant components of the U.S. ocean infrastructure are aged or obsolete and that, in some cases, current capacity is insufficient to meet the needs of the ocean science and operational community.

Thirteen federal agencies with activities in ocean and coastal science develop, build, and operate infrastructure components to support their science missions, often in partnership with academic institutions. For very expensive or unique assets, federal organizations can develop shared resources, such as supercomputers and data centers.

The National Science Foundation (NSF) is the lead federal agency for supporting science and engineering infrastructure for academia, and is also the major supporter of basic science. However, NSF's share of support for ocean infrastructure has declined over the recent past as priorities have shifted to other science sectors. NSF funds large research facilities (those costing hundreds of millions of dollars) through its Major Research Equipment and Facilities Construction account. Small infrastructure projects (costing millions of dollars or less) have generally been funded through its regular disciplinary science programs. In 1997, NSF launched the Major Research Instrumentation program to provide additional support for instrumentation ranging in cost from $100,000 to $2 million, but the funding for this program falls far short of the needs and opportunities in the academic community. There is currently no NSF program dedicated to funding mid-size facilities (costing millions to tens of millions of dollars), although the disciplinary research programs would be very hard pressed to support such investments.

In 2003, the National Science Board (NSB), the governing board of the NSF, concluded that academic research infrastructure has not kept pace with rapidly changing technology, expanding opportunities, and increasing numbers of users.[2] New technologies allow researchers to be remotely connected to a sophisticated array of facilities, instruments, and databases; however these technologies are not readily available to the majority of scientists. NSB concluded that additional federal investments would be needed to provide scientists access to the latest and best infrastructure and technologies.

Gaps in Technology Development

In both the federal and academic arenas, it is difficult to incorporate rapidly changing technology into ongoing activities. However, to provide the public with useful information and products, the science community must learn how to rapidly transition marine technologies from the research and development stages to sustained applications. A prime example is the difficulty involved in transitioning the National Aeronautics and Space Administration's (NASA's) research-oriented ocean observing sensors into operational use at the National Oceanic and Atmospheric Administration (NOAA). Better planning and new funding will be needed to bridge this gap, allowing new technologies to revolutionize ocean science and management.

Furthermore, a decline in U.S. leadership in marine technology development will result in increasing reliance on foreign capabilities. Japan, the European Community, India, and China are all making great strides in technology development and have the potential to out compete the United States in the near future. Changes in the policies and priorities of foreign nations, and potential reluctance to freely share technology and environmental information with the United States, may put the nation's ocean research and observation activities at risk.

In 2001, the U.S. Commission on National Security/21st Century reported that federal investment in non-defense technology development has remained flat since 1989 and that the United States is losing its technological edge in many scientific fields.[3]

Maximizing Resources through Collaboration

Ocean science has become a highly interdisciplinary field, requiring close collaborations among natural, physical, and social scientists, engineers, and information technology experts. Because few organizations possess the facilities and expertise to support all major fields of investigation, ocean projects frequently depend on partnerships among federal, state, academic, and private institutions, both U.S.- and foreign-based.

An overarching message from the Inventory of U.S. Coastal and Ocean Facilities (Appendix 5) is the need for continued partnerships among public and private entities to reduce costs, leverage resources, and encourage information sharing. Many successful collaborations have formed across the nation and around the world in recent decades. Ocean and coastal laboratories are frequently focal points for these efforts, drawing additional resources and new facilities supported by government, private, or academic institutions to advance the science capabilities of a region.

For example, Narragansett, Rhode Island is home to a strong coalition of diverse research organizations, including the Atlantic Ecology Division of the U.S. Environmental Protection Agency's (EPA's) National Health and Environmental Effects Research Laboratory, NOAA's Northeast Fisheries Science Center Narragansett Laboratory, and the University of Rhode Island's Graduate School of Oceanography. Similarly, at the Hollings Marine Laboratory in Charleston, South Carolina, NOAA's National Ocean Service and the National Institute of Standards and Technology have partnered with the South Carolina Department of Natural Resources, the College of Charleston, and the Medical University of South Carolina to construct and operate a state-of-the-art marine laboratory dedicated solely to collaborative, interdisciplinary research.

Consortia and joint programs, with facilities that support several institutions, create marine science communities that interact closely, share knowledge, enhance career pathways, and promote collaboration among government, academic, and private sectors. The most cost-effective means of making infrastructure available to the largest number of scientists is to emphasize partnering among many institutions from all sectors.

Back in 1969, the Stratton Commission already recognized that the technological and scientific demands of global ocean research would overtax the means of any single nation, stressing the need for international partnerships.[4] Realizing the expense involved in building and maintaining infrastructure and developing new technologies, nations have joined together in extremely successful ways. Current examples of such shared resources include satellite-based sensors, Argo profiling floats that measure meteorological and ocean variables as part of the Global Ocean Observing System, the Global Climate Observing System, and the Integrated Ocean Drilling Program. The United States should continue to pursue partnerships with foreign nations for high-cost technology development activities with worldwide applications, while ensuring that foreign efforts are complementary to those in the United States, not replacements for them.

A National Strategy

Despite the growing need to improve ocean observing, forecasting, and management, the federal government has yet to develop a long-range strategy to support the civilian infrastructure and technology needed for both research and operational purposes. Although federal agencies have made efforts to improve their coordination through the National Oceanographic Partnership Program and other mechanisms, infrastructure and technology planning is still not conducted in an integrated fashion that reflects regional, national, and international priorities.

Although some facilities are operated with joint funding, interagency budgeting for shared facilities has had limited success due to differences in Congressional oversight and financial and project approval processes. As a result, facilities are typically constructed or modernized in a piecemeal fashion, often through earmarked congressional funding. A unified national strategy can help achieve and maintain an appropriate mix of federally supported, modern ocean facilities that meet the nation's needs for quality resource management, science, and assessment. Federal coordination could also focus support on developing and transferring technologies that numerous agencies desire for operational activities.

Recommendation 27–1. The National Ocean Council's Committee on Ocean Science, Education, Technology, and Operations should develop a national ocean and coastal infrastructure and technology strategy, including funding and implementation requirements.

The strategy should include:

- *consideration of the existing capabilities of academic, state, and private entities.*
- *identification of emerging technologies that should be incorporated into agency operations.*
- *mechanisms for establishing international partnerships.*
- *guidelines for incorporating the strategy into agency plans for technology development and facilities construction and consolidation.*
- *specific priorities for acquiring and upgrading ocean research infrastructure, including vessels, facilities, instrumentation, and equipment.*

The development of needed ocean technologies—whether identified by the national strategy or through interagency communication—requires directed funding and coordination. Federal agency programs will benefit by having a centralized office responsible for accelerating the transition of technological advances made by federal and academic laboratories into routine operations. NOAA, by virtue of its mission, is the logical agency for this role.

Recommendation 27–2. The National Oceanic and Atmospheric Administration should create, and Congress should fund, an Office of Technology to expedite the transition of experimental technologies into operational applications. This office should work closely with academic institutions, the regional ocean information programs, the National Science Foundation, the U.S. Navy, the National Aeronautics and Space Administration, and other relevant agencies to achieve its mission.

Periodic Reviews and Assessments

In conducting its inventory of U.S. coastal and ocean facilities, the Commission discovered few long-term plans for maintaining, replacing, or modernizing facilities (Appendix 5). As the first such assessment conducted in twenty-two years, the need for periodic future infrastructure assessments became obvious. A meaningful accounting of national assets, facilities, and human resources requires regular updates to ensure that the national strategy is based on an up-to-date understanding of capacity, capabilities, and trends.

Developing a national facilities database would help plan for asset replacement or refurbishment. Furthermore, organizing such a database along regional lines would help identify the facility needs of each region and improve the prospects for resource sharing. State and private-sector capabilities should be included in the inventory to alert scientists to the existence and potential availability of these assets.

Recommendation 27–3. The National Ocean Council should update the assessment of U.S. ocean and coastal infrastructure and technology, including federal, state, academic, and private assets, every five years.

The assessment should include information on:

- *the location, ownership, availability, remaining service life, and replacement cost for a wide range of ocean infrastructure assets.*
- *maintenance and operational costs associated with these assets.*
- *associated human resource needs.*
- *the outcomes of past federal investments in ocean technology and infrastructure, with recommendations for improvements.*

Funding the Modernization of Critically Needed Assets

Too often, federal and state agencies have had to delay, reduce, or cancel infrastructure upgrades at government facilities during the past decade due to budgetary constraints or changing agency priorities. Similar challenges arise within the academic community which must balance the cost of expensive facilities with other institutional priorities.

Recent state fiscal crises have exacerbated the problem at public universities, and a significant decline in the value of many endowment funds during the same period has delayed modernization and expansion activities at many private institutions. Funds dedicated for operations and maintenance of existing equipment have also declined. As a result, significant parts of the ocean and coastal infrastructure are outmoded, limiting the progress of ocean research and hindering the prospects for using science to improve management practices.

Essential Infrastructure and Technology Components

The following discussion provides a summary of the condition of several major ocean science infrastructure categories, highlighting those most in need of coordinated planning and increased investment.

Surface Vessels

Despite the increasing availability of moored instruments, drifters, gliders, and satellites to collect ocean data, the need will remain for traditional ships to conduct research, exploration, operations, and education. But insufficient vessel capacity, vessel deterioration, and outdated shipboard equipment and technology hinder the conduct of vessel-based science and operations. In some cases, these conditions also present safety issues and increase the cost of routine maintenance and operation.

The nation's existing 400-plus surface vessels for research and operations are spread across federal and state agencies, universities, private research institutions, and private industry. The five largest U.S. fleet operators conducting global, coastal, and near shore research and mission operations are NOAA, the U.S. Navy, the U.S. Environmental Protection Agency, the U.S. Geological Survey, and the U.S. Department of the Interior, which together own and operate the forty-one primary vessels of the federal fleet associated with ocean science and operations. In addition, fifty-four academic institutions and five federal agencies (NSF, the Office of Naval Research (ONR), NOAA, USGS, and the U.S. Coast Guard) operate and use the twenty-nine vessels in the University National Oceanographic Laboratory System (UNOLS) fleet. Most coastal states also own and operate vessels of various sizes and mission capabilities to satisfy state needs. A significant and growing number of privately-owned research and operations vessels are also being used by federal and state agencies and academic institutions through contract or lease arrangements, particularly for highly specialized work.

The Navy survey fleet is relatively new and generally maintained at a level adequate to meet defense mission requirements. The Coast Guard operates three icebreakers, which provide polar research capabilities. This fleet was recently updated with a new vessel specifically designed for research. NOAA has enlarged its fleet by refitting surplus Navy vessels and launching a ten-year plan to build four specialized fishery research ships at $52 million per vessel.[5] Two of the ships are under construction, but funding has not been finalized for the remaining two. USGS and EPA need new vessels to satisfy basic mission mandates, but currently have no funding or plans to acquire these resources.

While all of the agency fleets would benefit from upgrades, the UNOLS fleet is *in extremis*. Twelve of the seventeen largest UNOLS ships will reach the end of their service life over the next fifteen years, and almost all UNOLS ships need immediate and significant enhancements.[6]

The development of the Integrated Ocean Observing System (IOOS, discussed in Chapter 26) will intensify the demand for ship support to install and maintain system components. This capacity is not available in the research fleet today, nor is it foreseen in the near future. With the start of the international Integrated Ocean Drilling Program, the United States has pledged to provide a modernized non-riser drilling vessel with enhanced coring and drilling capabilities at an estimated cost of $100 million.[7]

Modern research ships are designed as flexible multi-mission platforms that can accept different instrument systems to suit particular projects. However, the instrumentation that is built in (such as sonars, mapping systems, or computer labs) must be considered part of the vessel. These onboard technologies typically require much more frequent maintenance and upgrades than the vessels themselves. Thus, fleet planning strategies need to consider the costs of maintaining existing instrumentation and integrating emerging technologies.

The National Ocean Partnership Program established the Federal Oceanographic Facilities Committee to oversee oceanographic vessel use, upgrades, and investments. The committee's 2001 plan for recapitalization of the academic research fleet is an excellent example of successful interagency planning at the national level.[8] Unfortunately, the plan has not yet been funded or implemented.

Undersea Vehicles

Scientists working in the deep ocean have made fundamental contributions to understanding ocean and planetary processes and the nature of life itself. Further scientific breakthroughs are likely if more regular access to the ocean depths can be provided. Ninety-seven percent of the ocean floor can be accessed by existing undersea vehicles with depth capabilities of around 20,000 feet. The remaining three percent—an additional 16,000 feet of ocean depth—remains largely inaccessible, although it includes most of the deep ocean trenches and comprises an area the size of the continental United States, Alaska, and about half of Mexico combined.

Human-occupied deep submersible vehicles came into operation in the late 1950s, followed by tethered remotely operated vehicles, and later by autonomous underwater vehicles. All three types of vessels are still used, and this variety allows researchers to choose the best tool for their needs, based on factors such as task, complexity, cost, and risks.

Today French, Russian, and Japanese human-occupied submersibles regularly work at depths of 20,000 feet or more. The last such vehicle in the United States was the *Sea Cliff*, which was retired in 1998 and not replaced. U.S. capability today is limited to the *Alvin*, built in 1964, which can only descend to 15,000 feet and stay submerged for short periods. For missions of long duration, the United States relies on the Navy's NR-1 nuclear research submarine, which can stay submerged for thirty days but has a maximum depth of only 3,000 feet. The NR-1 was constructed in 1969, and its service life will end in 2012.

The United States has a well-developed remotely operated vehicle (ROV) industry, and ROVs are readily available for academic and industrial purposes. The last twenty-five years have witnessed extraordinary advances in the field of sub-sea robotics, developed mainly for the oil and gas industry, and there is a wide array of ROVs available with working depths of 9,800 feet. Current U.S. ROV capabilities are led by *Jason II*, with a maximum operating depth of 21,325 feet, but it is the only vehicle in the federal fleet capable of reaching this depth. Federal funding has expedited the development of ROVs that can dive to 23,000 feet and deeper, but a concerted effort will be needed to make deep-water capabilities more economical and accessible. All submersibles in the federal fleet, including *Alvin* and *Jason II*, are currently housed at the National Deep Submergence Facility at the Woods Hole Oceanographic Institution. The facility is funded through a partnership among NSF, ONR, and NOAA.

The U.S. autonomous underwater vehicle (AUV) industry has just begun to emerge from the research, development, and prototype phase. Over the past decade, close to sixty development programs have been initiated throughout the world, and approximately 175 prototypes have been developed. About twenty of these programs remain active, with at least eight in the United States. While the primary financial drivers of AUV development in the United States have been the U.S. military and the oil industry, significant programs are in place at a few academic institutions and private institutes.

A 2003 report by the National Research Council found that the scientific demand for deep-diving vehicles is not being met.[9] The report supports a mix of vehicles to support current and future research needs. Recommendations include: (1) setting aside funds at the National Deep Submergence Facility to gain access to vehicles outside the federal fleet for specific missions; (2) acquiring a second ROV to join *Jason II* by 2005, at a cost of approximately $5 million; and (3) initiating an engineering study to evaluate various options for replacing *Alvin*, with a goal of providing submergence capability up to 21,000 feet, at a cost of approximately $20 million. The report noted that in time and with a higher level of funding, additional platforms with greater capabilities could be profitably added to the fleet.

Dedicated Ocean Exploration Platforms

The success of a robust national ocean exploration program (described in Chapter 25) will depend on the availability of sufficient vessel support, particularly ships and submersibles. Given that the existing suite of platforms requires upgrading just to meet current demands—not to mention the additional needs of the IOOS—implementation of a robust, national ocean exploration program will require additional support facilities. These assets should provide dedicated support for exploration missions and the flexibility to investigate many ocean areas and environments.

In 2003, the National Research Council recommended U.S. participation in an international exploration effort and discussed the benefits of providing a $70 million modern flagship and modernized underwater vehicles and platforms.[10] Such assets should be included in the national strategy for ocean infrastructure and technology.

Airborne Ocean Science Platforms

Piloted and autonomous aircraft are an integral part of modern ocean research and operations. They are needed for precise airborne observation and measurements of the ocean, air–sea interface, and atmosphere. Many multidisciplinary, ocean–atmosphere field projects require a mix of observational platforms, particularly aircraft teamed with ships and satellites. Research aircraft are also instrumental in developing new satellite and airborne sensors. The national airborne fleet is operated by a partnership of federal agencies and academia. Private aircraft are often used for specialty and operational projects such as aerial mapping, marine mammal surveys, and supply missions.

The future of airborne ocean science and monitoring rests on the increased availability of autonomous or remotely-piloted aircraft. These research platforms are being developed with a greater range, duration, and ceiling than conventional aircraft, and present less risk when operating in hazardous environments. The research community has suggested the need for a worldwide fleet of autonomous aircraft for ocean and atmospheric observation by 2005.[11] NASA, ONR, and NSF currently have active autonomous airborne ocean research programs, and are working to develop additional resources.

The Interagency Coordinating Committee for Airborne Geoscience Research and Applications, which is composed of federal agencies and academic institutions that operate research aircraft programs, works to improve cooperation, foster awareness, and facilitate communication among its members, and serves as a resource to senior managers. In an effort to coordinate ocean research aircraft, UNOLS has recently designated certain assets as National Oceanographic Aircraft Facilities.

The demand for these assets is increasing, particularly as collaborative ocean-atmosphere projects become more common. Demand currently exceeds availability. Inadequate funding for research flight time is exacerbating the problem. Furthermore, as with surface vessels, emerging technologies and updated safety and personnel requirements will require significant funding that must be included in planning.

In 2003, NOAA drafted a ten-year plan for airborne platforms that provides an extensive analysis of agency requirements. The plan included an examination of historical flight requests, allocations, and budgets, and delineated future requirements, contracts for service, and a recapitalization schedule and cost.[12]

Laboratories and Instrumentation

Maintaining academic laboratory space and instrumentation over the past decade has been challenging due to increased construction of new facilities to meet rising student and faculty needs and increased upkeep needs for aging facilities. This problem is aggravated by the prohibition against academic institutions setting aside adequate federal funds for ongoing maintenance and replacement. A recent RAND study estimated that the true cost of providing facilities and administration to support research projects is about 31 percent of the grant amount.[13] However, federal regulations limit the share that can be covered with federal funds to between 24 and 28 percent, leaving the difference to be covered by the institutions.

In 2002, the Consortium for Oceanographic Research and Education surveyed eighty-six non-UNOLS academic ocean programs to examine facility age and replacement plans (Appendix 4). Relatively few institutions had replacement plans for their facilities, and a number of institutions noted that lack of available funds was the primary factor preventing planning and upgrades. Yet increases in both lab space and instrumentation capacity will be essential for the continued conduct of cutting-edge ocean research.

Many federal facilities are deteriorating due to growing budget pressures and new mandates related to safety, homeland security, and environmental health compliance. NOAA characterizes its need for improvements to equipment and labs as a major impediment to future science capabilities. In a 2002 Performance Review Report, NOAA showed holdings of 800 buildings at 500 installations, representing 6 million square feet of space.[14] Approximately 50 percent of the properties were over 30 years old, and there was a backlog of 316 maintenance and repair projects. Of the estimated $65 million in costs needed to remedy this backlog, $25 million was required just to address health and safety problems. If the fiscal year 2002 facility funding level of $3.2 million is maintained over the next few years, 60 percent of this backlog will remain in 2010. In its Strategic Plan for 2003-2008, NOAA presented a strategy for improving infrastructure development, construction, consolidation, and maintenance, but additional funding will be needed to implement the plan.[15]

Advanced Telecommunications Technology and Broadband Capabilities

Federal satellite communications infrastructure is needed to provide affordable, global broadband coverage to support ocean observations and exploration. Current coverage does not provide links to important polar regions or portions of the Southern Ocean. Advanced communication capabilities are also required for scientists to remotely operate ocean exploration vehicles, similar to the highly successful use of space probes. These telecommunication technologies also provide excellent educational opportunities for the general public, allowing them to participate in virtual voyages to deep and inaccessible parts of the ocean. Telepresence— the transmission of real-time, high-quality video, audio, and other digital data from undersea exploration sites over the Internet—will demand modern broadband data transfer capabilities.

A variety of other research activities require upgrades in the current data transmission infrastructure, such as the fiber optics needed for cabled sensor systems. The IOOS will require transmission of large amounts of coastal, oceanic, and atmospheric data in real and near-real time, demanding advanced telecommunications technology and infrastructure. Active partnerships between ocean scientists and the private telecommunications industry will be crucial to ensure that the United States has the capability to transmit and assimilate the data streams of the future.

Environmental Sensors

Development of new environmental sensors—an essential component of the IOOS—will require a substantial federal investment. Sensors for measuring basic oceanographic parameters such as currents, temperature, and salinity are already widely available, but sensors that illuminate the chemistry and biology of the ocean are just emerging. The new generation of sensors will be able to measure such parameters as carbon dioxide, acidity, alkalinity, dissolved oxygen, nitrates, photosynthetically active radiation, spectral radiance and irradiance, back-scattered light, and stimulated fluorescence. Some of the innovative biological technologies currently being investigated include acoustic monitoring and optical scanning systems for identifying and tracking marine life, DNA probes for identifying harmful algal blooms, and nanotechnology sensors for monitoring potentially harmful pathogens. Although prototypes exist, many sensors still need considerable development before they can be expected to operate unattended for long periods of time in the harsh ocean environment. Federal support and multisector partnerships will be necessary to turn innovative environmental sensors into operational components of the national IOOS.

A Federal Modernization Fund

Coordinated federal support for ocean research infrastructure could be achieved through the establishment of a modernization fund. Such a fund would be used to build or upgrade critical facilities and acquire related instrumentation and equipment. It would also provide a mechanism to coordinate similar equipment purchases across agencies, where feasible, creating significant economies of scale.

Recommendation 27–4. Congress should establish a modernization fund for critical ocean infrastructure and technology needs. Spending priorities should be based on the National Ocean Council's ocean and coastal infrastructure and technology strategy.

High-priority areas for funding include the following:

- *the renewal of the University National Oceanographic Laboratory System ocean and air fleets, including the Integrated Ocean Drilling Program ship, and deep-submergence vehicles.*
- *the completion of the third and fourth dedicated fishery research vessels.*
- *the acquisition of vessels and infrastructure needed for an expanded national ocean exploration program.*
- *ongoing operations, maintenance, and modernization of existing assets, including laboratory facilities.*

Creating Virtual Marine Technology Centers

Fundamental oceanographic questions require the best scientific and engineering talent working cooperatively to obtain answers. Interdisciplinary oceanographic research programs typically require large numbers of platforms and sensors operating in a coordinated manner. While new technologies are enabling the creation of more powerful sensors, robotic platforms, and ocean observing systems, it would be extremely difficult for any individual research group to acquire all these technologies and master increasingly complex instrumentation. By sharing expensive technologies, infrastructure, and expertise, more investigators will have greater access to these assets.

Virtual centers will require a smaller federal investment than if numerous institutions all attempt to acquire the same essential instrumentation. By electronically linking existing academic, government, and private-sector capabilities and instrumentation, virtual centers for ocean and coastal technology could maximize the use of the excellent capabilities and facilities already present in the United States. These interdisciplinary virtual centers could take advantage of submersibles in one location, ocean observations halfway around the globe, and socioeconomic studies coordinated at another location. Infrastructure components available through the center could be used for small-scale, pilot projects that would normally not have access to such facilities. Investigators could apply for grants to join an ongoing team linked by computers, not geography. The multipurpose focus of each center also lends itself to the development of new approaches to education and public outreach.

The centers will also serve as incubators for infrastructure innovations and new technologies necessary to achieve and sustain national competitiveness in ocean science and engineering research. A strengthened NOAA, as the lead ocean observation, operations, and management agency, is the logical organization to provide funding for these virtual marine technology centers.

Recommendation 27–5. The National Oceanic and Atmospheric Administration should establish, and Congress should fund, national virtual marine technology centers to provide coordinated access, through electronic means, to cutting-edge, large-scale research technologies.

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CHAPTER 28:
MODERNIZING OCEAN DATA AND INFORMATION SYSTEMS

Ocean and coastal research and observational activities are generating new data at ever-increasing rates—data that must eventually be analyzed, distributed, and stored. The nation's ocean and coastal data management systems should be modernized and integrated to promote interdisciplinary studies and provide useful information products for policy makers, resource managers, and the general public. Better interagency planning is needed to coordinate federal data management. An information management and communications program will help produce operational ocean and coastal forecasts and disseminate information products relevant to national, regional, and local needs. Ultimately, the goal should be to transition all environmental data archiving, assimilation, modeling, and information systems, which are currently divided by environmental sectors, into a fully integrated Earth environmental data system.

TURNING OCEANS OF DATA INTO USEFUL PRODUCTS

Ocean and coastal data are essential for understanding marine processes and resources. They are the foundation for the science-based information on which resource managers depend. Previous chapters have provided ample evidence of the importance of data from ocean, coastal, and watershed observations; but processing these data, and converting them into information products useful to a broad community of end users, remains a huge challenge.

For the purpose of this discussion, *data* are defined as direct measurements collected during scientific research, observing, monitoring, exploration, or other marine operations. *Information*, on the other hand, includes both *synthesized products* developed through analyses of original data using statistical methods, interpolations, extrapolations, and model simulations, and *interpreted products* developed through incorporation of data and synthesized products with additional information that provides spatial, temporal, or issue-based context.

There are two major challenges facing data managers today: the exponentially growing volume of data, which continually strains data ingestion, storage, and assimilation capabilities; and the need for timely accessibility of these data to the user community in a variety of useful formats. Meeting these challenges will require a concerted effort to integrate and modernize the current management system. The ultimate goal of improved data management should be to effectively store, access, integrate, and utilize a wide and disparate range of data needed to better understand the environment and to translate and deliver scientific results and information products in a timely way.

REVIEWING THE DATA MANAGEMENT STRUCTURE

Data centers throughout the nation collect and analyze environmental data and information. Because these centers often operate in isolation, users who need to gather and integrate data from multiple sources can face an inefficient and lengthy process.

Types of Data Centers

National Civilian Data Centers

The national data centers that archive and distribute environmental data have been evolving since the late 1950s. Federal science agencies maintain ten national data centers, some with regional extensions (Table 28.1). These centers collect, archive, and provide access to an assortment of publicly available data sets streaming in from local, regional, and global environmental observing systems. Nine of the centers are run by federal agencies, including the National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), National Aeronautics and Space Administration (NASA), and U.S. Department of Energy. The remaining center is housed at Columbia University and is sponsored by twenty-two federal and nonfederal organizations.

Each federal data center collects and archives complementary data and information sets. Yet for the most part, these centers are disconnected from each other, and attempting to gather and integrate data from several centers can be a time-consuming and sometimes impossible task due to differences in storage formats and computer software. Ever-increasing amounts of incoming data will only exacerbate this untenable situation, impeding the creation and dissemination of critical information products.

Stages in Data and Information Management

- *Collection*—gathering data from a range of sources, including observing systems and field research investigations.
- *Ingestion*—receiving data at data centers and processing it for entry into the archives.
- *Quality control*—determining the reliability of data received.
- *Archiving and maintenance*—standardizing formats, and establishing databases and security at repository centers.
- *Rescue and conversion*—identifying and reformatting historical data for placement into the archives.
- *Access and Distribution*—making data and information products available to end users.
- *Modeling*—using data in numerical computer models to describe systems, theories, and phenomena related to natural processes.
- *Assimilation and Data Fusion*—assembling and blending data, and combining them with models in optimal ways for operational and research purposes.

Useful Terms

- *Metadata*—information about the origin and attributes of data that allows users to find, understand, process, and reuse data and data products.
- *Visualization tools*—methods of visually displaying data, such as visualization theaters, computer displays, and maps and charts.
- *Communication networks*—telecommunications infrastructure that transfers data from observing systems to data centers, and from these centers to end users.

Distributed Active Archive Centers

NASA operates eight Distributed Active Archive Centers (DAACs) that are separate from the civilian data centers. The primary objectives of these DAACs are to focus on data from specific missions and experiments, not long-term stewardship of data. Implementation of the DAACs has been costly, and they have not yet fulfilled their potential.

NASA is now trying to organize the DAACs into a federation of databases managed by academia and industry, possibly transitioning away from the structure of the current centers. As part of this new organizational structure, and in an attempt to achieve long-term data storage and coordination, NASA data are supposed to be transferred to NOAA or USGS within fifteen years after their collection.

Table 28.1. Current National Civilian and Military Data Centers
Listed below are the existing federal data centers along with their sponsoring agencies and scientific specialties.

Center	Agency	Specialty
National Data Centers		
Carbon Dioxide Information Analysis Center (CDIAC)	U.S. Department of Energy	Atmospheric trace gases, global carbon cycle, solar and atmospheric radiation
Center for International Earth Science Information Network (CIESIN)	Columbia University (supported by contracts from 22 nonfederal and federal agencies)	Agriculture, biodiversity, ecosystems, world resources, population, environmental assessment and health, land use and land cover change
Earth Resources Observation Systems (EROS) Data Center (EDC)	U.S. Geological Survey (USGS)	Cartographic and land remote-sensing data products
National Earthquake Information Center (NEIC)	USGS	Earthquake information, seismograms
National Climatic Data Center (NCDC)	National Oceanic and Atmospheric Administration (NOAA)	Climate, meteorology, alpine environments, ocean–atmosphere interactions, vegetation, paleoclimatology
National Geophysical Data Center (NGDC)	NOAA	Bathymetry, topography, geomagnetism, habitat, hazards, marine geophysics
National Oceanographic Data Center (NODC)	NOAA	Physical, chemical, and biological oceanographic data
National Snow and Ice Data Center (NSIDC)	NOAA	Snow, land ice, sea ice, atmosphere, biosphere, hydrosphere
National Coastal Data Development Center	University of Colorado (under cooperative agreement with NOAA)	Data relevant to coastal managers
National Space Science Data Center (NSSDC)	National Aeronautics and Space Administration (NASA)	Astronomy, astrophysics, solar and space physics, lunar and planetary science
Distributed Active Archive Centers (DAACs)		
Oak Ridge National Laboratory (ORNL) DAAC	NASA	Terrestrial biogeochemistry, ecosystem dynamics
Socioeconomic Data and Applications Center (SEDAC)	NASA	Population and administrative boundaries
Land Processes (EDC) DAAC	NASA	Land remote-sensing imagery, elevation, land cover
National Snow and Ice Data Center (NSIDC) DAAC	NASA	Sea ice, snow cover, ice sheet data, brightness, temperature, polar atmosphere
Goddard Space Flight Center (GSFC) DAAC	NASA	Ocean color, hydrology and precipitation, land biosphere, atmospheric dynamics, and chemistry
Langley Research Center (LaRC) DAAC	NASA	Radiation budget, clouds, aerosols, and tropospheric chemistry
Physical Oceanography (PO) DAAC	NASA	Atmospheric moisture, climatology, heat flux, ice, ocean wind, sea surface height, temperature
Alaska Synthetic Aperture Radar (SAR) Facility DAAC	NASA	Sea ice, polar processes
Military Data Centers of Particular Importance to Ocean-related Issues		
Naval Oceanographic Office	U.S. Navy	Bathymetry, hydrography, oceanography
Fleet Numerical Meteorology and Oceanography Center	U.S. Navy	Atmosphere and oceans

Source (except military centers): National Research Council. *Government Data Centers: Meeting Increasing Demand*. Washington, DC: National Academy Press, 2003.

Military Data Centers

Several military data centers exist in addition to the civilian centers. Of particular importance are the U.S. Department of Defense assets at the Naval Oceanographic Office and the U.S. Navy's centers for ocean observation and prediction, which include the Fleet Numerical Meteorology and Oceanography Center, the Naval Oceanographic Office, and the Naval Ice Center. These centers are integrated with the civilian sector's national data centers through memoranda of agreement, primarily with NOAA, NASA, the Department of Energy, and the National Science Foundation (NSF). The purpose is to incorporate certain classified data into civilian research and operational products while retaining their confidentiality.

Other Specialized Data Centers

Fifteen discipline-based World Data Centers exist in the United States that collect and archive data related to atmospheric trace gases, glaciology, human interactions in the environment, marine geology and geophysics, meteorology, oceanography, paleoclimatology, remotely sensed land data, seismology, and solar-terrestrial physics. Individual states also operate data centers associated with certain state environmental offices, such as weather or geological offices. Independent specialized data collections have also been assembled by interagency groups, university and research centers, and consortia in various fields of science.

Ocean and Coastal Data

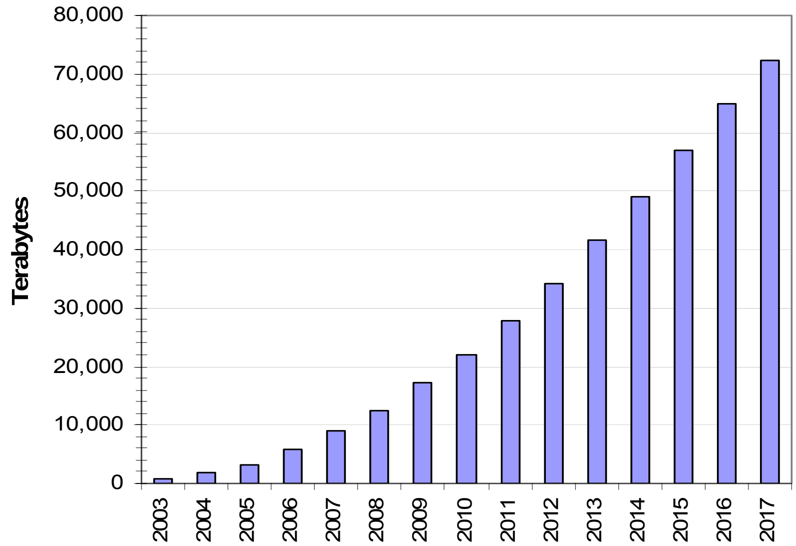
Ocean, coastal, and watershed data are primarily located in NOAA, NASA, USGS, the U.S. Environmental Protection Agency, and the Navy. NOAA has the unique mission of archiving environmental data, with a special focus on ocean and coastal data, and making it accessible to support management and economic decisions and ecosystem-based research. NOAA carries out this mission through its national data centers (five of the ten listed above), which jointly manage large collections of atmospheric, oceanographic, and geophysical data. Despite the fact that these five centers are co-located within NOAA, they function independently of each other, and it remains difficult for users to acquire and integrate data in a seamless manner. Other agencies are also experiencing problems with incorporating, storing, and distributing large amounts of environmental data. For example, USGS has struggled with the large volumes of Landsat satellite data which have historically been very helpful in ocean and coastal research and management activities.

COPING WITH THE FLOOD OF INCOMING DATA

Throughout the 1990s and into this century, all of the national military and civilian data centers have experienced tremendous growth in the inflow and archiving of data. This growth is expected to continue; NOAA data holdings are projected to grow by a factor of 100 between 2002 and 2017 (Figure 28.2).[1] This projection may actually be an underestimate if currently envisioned automated data collection systems come on-line. The civilian data centers make data available to support operational products and forecasts and to fill specific requests. During the 1990s, NOAA's on-line data requests grew to 4 million a year (an average of 11,000 per day), while off-line requests doubled to a quarter of a million (Figure 28.3). Although many users increasingly rely on electronic access, only 4 percent of NOAA's digital data archive is currently available on-line and many of NOAA's historical data sets have yet to be converted to digital form.[2]

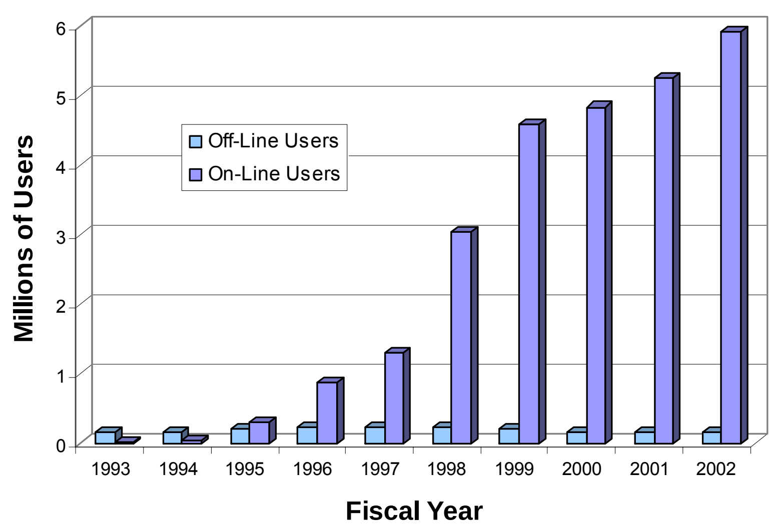
Ongoing improvements to ocean databases have substantially increased the amount of available data and have dramatically improved accessibility. However, data collection and information needs continue to outpace archiving and assimilation capabilities.

Figure 28.2. The Flood of Ocean and Coastal Data into NOAA



Between 2002 and 2017, NOAA's data holdings are expected to grow by a factor of 100, to a value of 74 million gigabytes. (One gigabyte roughly equals one billion bytes; one terabyte equals about one thousand gigabytes.)
Source: National Oceanic and Atmospheric Administration. *The Nation's Environmental Data: Treasures at Risk: A Report to Congress on the Status and Challenges for NOAA's Environmental Data Systems*. Washington, DC: U.S. Department of Commerce, 2001.

Figure 28.3. The Growing Demand for Ocean Data



On-line users are requesting increasing amounts of environmental data and information from NOAA each year. Improved data handling practices are needed to address the growing volume of requests.
Source: National Oceanic and Atmospheric Administration. *The Nation's Environmental Data: Treasures at Risk: A Report to Congress on the Status and Challenges for NOAA's Environmental Data Systems.* Washington, DC: U.S. Department of Commerce, 2001.

Reinventing Data and Information Management

Several improvements can help make the national system for storing and distributing ocean and coastal data more effective. Agencies tasked with collecting, archiving, assimilating, and disseminating data need to increase their cooperation and coordination and provide faster, easier, and more unified access to raw and processed data. In return, scientists and other data generators need to feed valuable, high quality data into the national system in a timely way.

Interagency Planning

Growing observational capabilities, improved numerical models of the world, and formal methods for linking data and models now permit scientists to study ecosystems with an unprecedented degree of realism. The impact of these developments on the understanding of oceanic processes pervades all disciplines and fuels cross-disciplinary links between physical, biological, and chemical oceanography, marine geology and geophysics, and atmospheric sciences.

Nevertheless, inadequate information technology infrastructure inhibits progress. Continuing efforts to establish modeling and data assimilation nodes within the National Ocean Partnership Program agencies provide just one example of a high-priority activity where infrastructure limitations are acute. Topics of particular concern include:

Data Incorporation—Scientists and managers need to combine data from disparate sources to produce information products, often in real time. As computer software and hardware technologies evolve, data stored in older formats need to be upgraded. In particular, enormous archives of historical data exist only in nondigital formats. Differences in data protocols also remain among scientific fields; physical and biological variables are measured using very different parameters. New methods are needed to incorporate biological data into ocean and coastal information products.

Computer Hardware—Ocean scientists are expected to require 10 to 1,000 times the current hardware capacity over the next five to ten years, with the most critical bottlenecks occurring in the availability of computer processing power, memory and mass-storage capacity, and communications network bandwidth. [3] Many oceanographic models have grown in computational size to the point that they require dedicated, long-term computing that exceeds the time available on computers currently used for most medium- and large-scale ocean projects.

Software and Modeling—Software challenges include the need to redesign models and methods to assimilate new data sources and improve visualization techniques to deal effectively with increasing volumes of observations and model outputs. There is a need throughout the ocean science community for well-designed, documented, and tested models of all types. Models of living systems lag significantly behind those related to physical variables; the capacity to run simulations of organisms, populations, and ultimately ecosystems, is currently not available.

Human Resources—In the early days of collecting and storing environmental data in digital formats, many of the technical staff were environmental scientists who gained experience through on-the-job training and trial and error. By the mid-1980s, this type of education was wholly inadequate to meet the ever-increasing complexity of computer hardware and software systems, and the volumes of digitized data being collected and archived. As technical requirements grew, the federal government fell far behind academia and the private sector in attracting and retaining highly trained experts, particularly because government pay scales for information technology specialists were well below those of the private sector. This scenario continues today. A strategy is needed for attracting and retaining highly trained technical staff in the federal government.

Meeting User Needs—Data and information must be available to a wide range of users, from scientists looking for raw data, to the individual interested in forecasts and other easily understandable information products. User needs should be determined at national, regional, and local levels. The regional ocean information programs, discussed in Chapter 5, will be an essential link to user communities when deciding on priorities.

An interagency group, dedicated to ocean data and information planning, is needed to enhance coordination, effectively use existing resources for joint projects, schedule future software and hardware acquisitions and upgrades, and oversee strategic funding. Most importantly, this entity will create and oversee implementation of an interagency plan to improve access to data at the national data centers, DAACs, and other discipline-based centers. The plan will need to be appropriately integrated with other national and international data management plans, including those for the Integrated Ocean Observing System (IOOS) and Global Ocean Observing System.

This coordination must extend beyond ocean data. The ocean community needs to take a leading role in broader environmental data planning efforts, such as the federal cyber infrastructure initiative. An interagency planning group could also coordinate the development of a viable, long-term strategy for partnering with the private sector to enhance environmental data and information management capabilities. This organization should not have an operational role, but instead should be responsible solely for interagency planning and coordination, similar to the role of Ocean.US for the IOOS.

Recommendation 28–1. Congress should amend the National Oceanographic Partnership Act to establish and fund Ocean.IT as the lead federal interagency planning organization for ocean and coastal data and information management. Ocean.IT should consist of representatives from all federal agencies involved in ocean data and information management, be supported by a small office, and report to the National Ocean Council's Committee on Ocean Science, Education, Technology, and Operations.

Ocean.IT should:

- *create an interagency plan to improve coordination between the existing data centers and integrate ocean and coastal data from different agencies and from the academic and private sectors.*
- *set priorities for archiving historical and nondigital data.*
- *coordinate shared resources and the acquisition of new hardware for use by the ocean sciences community.*
- *work with existing supercomputer centers to articulate and negotiate for ocean science needs.*
- *assess federal agency software needs and initiate interagency programs to create high-priority applications, such as new modeling programs.*
- *coordinate federal agency efforts to attract information technology expertise into the ocean sciences community.*
- *communicate with regional, state, and local organizations, including the regional ocean information programs, to determine user needs and feed this information back into agency activities.*

Access to Data and Information

There are two distinct types of data sought by users. Scientists are generally interested in calibrated, long-term time series of basic data that can be used to study topics such as atmospheric composition, ecosystem change, carbon cycles in the environment, the human dimensions of climate change, and the global water cycle. At the other end of the spectrum, the general public is most often interested in outcomes based on data analysis, such as forecasts and models, and do not wish to see the original data. Users seeking information products include commercial users, policy makers, and educators seeking information to develop curricula and class materials.

Information Products and Forecasts

Compared to a few decades ago, an impressive array of data and information products for forecasting ocean and coastal conditions is now available from a wide range of sources. A mechanism is now needed to bring these data together, including the enormous amounts of information that will be generated by the national IOOS, and use them to generate and disseminate products beneficial to large and diverse audiences.

At the national level, civilian operational ocean products and forecasts are produced mainly by NOAA's National Weather Service and National Ocean Service. The National Weather Service routinely issues marine and coastal information and forecasts related to meteorological conditions and issues marine warnings, forecasts, and guidance for maritime users. The National Ocean Service's Center for Operational Oceanographic Products and Services also collects and distributes oceanographic observations and predictions related to water levels, tides, and currents.

Military ocean informational products are produced mainly by two offices. The Fleet Numerical Meteorology and Oceanography Center provides weather and oceanographic products, data, and services to the operating and support forces of the Department of Defense. The Naval Oceanographic Office supplies global oceanographic products and generates strategic, operational, and tactical oceanographic and geospatial products to guarantee safe navigation and weapon/sensor performance.

While each of these offices possesses unique resources, infrastructure, and data, a partnership between them could lead to a new generation of ocean and coastal information and forecasts. A national ocean and coastal information management and communications program that builds on the Navy's model for operational oceanography would take advantage of the strengths of both agencies, reduce duplication, and more effectively meet the nation's information needs. This partnership would also allow for the prompt incorporation of classified military data into informational products without publicly releasing the raw data. A NOAA-Navy joint program would rapidly advance U.S. coastal and ocean analyses and forecasting capabilities using all available physical, biological, chemical, and socioeconomic data.

Private-sector involvement in creating ocean analyses and forecast products has matured over the last thirty years through highly successful public–private partnerships. Interactions between private companies and the national ocean and coastal information management and communications program could lead to the production of a wide range of general and tailored forecast and warning products. An interface between national forecasters at the NOAA–Navy program and the regional ocean information programs would also help identify ocean and coastal informational products of particular value at the regional and local levels.

Recommendation 28–2. The National Oceanic and Atmospheric Administration and the U.S. Navy should establish a joint ocean and coastal information management and communications program to generate information products relevant to national, regional, state, and local needs on an operational basis.

This new joint ocean and coastal information management and communications program should:

- *prioritize products and forecasts based on input from the regional ocean information programs, Ocean.IT, Ocean.US, and the National Ocean Council.*
- *base products and forecasts on all available data sources, including satellite and in situ data, and socioeconomic and biological data where applicable.*
- *create a research and development component of the program to generate new models and forecasts in collaboration with Ocean.IT, taking full advantage of the expertise found in academia and the private sector.*
- *develop a variety of dissemination techniques and educate users about access mechanisms, available products, and applications.*

Raw Data

Although many paths exist to access data, there is currently no focal point where users can go to gain access to all available ocean data and information. As a result, the process can be tedious, and the risk of missing key databases high. Interdisciplinary users face even greater challenges when attempting to integrate data sets from different centers. The varied data standards, formats, and metadata that have evolved over time make data exchange complex and unwieldy. Other problems arise when important data sets are kept by individual scientists or institutions, rather than being integrated into national databases.

One area of critical concern, particularly for coastal resource managers, is the integration of coastal data, including maps, charts, and living and non-living resource assessments. The user community is frustrated by the difficulties in accessing coastal geospatial data. Serious concerns continue regarding the timeliness, accuracy, and descriptions associated with coastal data, and the difficulties of integrating data sets from various sources. Coastal managers and researchers still lack a seamless bathymetric/topographic base map and database for the U.S. coast—an essential underpinning for improved understanding of the processes that occur across the land–sea interface. (The integration of maps and charts is also discussed in Chapter 25.)

Several innovative and highly promising interagency efforts to increase data accessibility are underway. The National Virtual Ocean Data System project is a primary example. Funded by the National Ocean Partnership Program, it facilitates seamless access to oceanographic data and data products via the Internet, regardless of data type, location of the storage site, the format in which the data are stored, or the user's visualization tools and level of expertise. The National Virtual Ocean Data System uses OPeNDAP technology that provides machine-to-machine interoperability within a highly distributed environment of heterogeneous data sets. This is similar to other successful Internet-based file sharing systems that allow users to access data (typically music files!) that reside on another individual's computer. The Ocean.US data management plan envisions that the National Virtual Ocean Data System will be implemented to allow access to IOOS data.

Recommendation 28–3. Ocean.IT should work with developers of the National Virtual Ocean Data System and other innovative data management systems to implement a federally-supported system for accessing ocean and coastal data both within and outside the national data centers.

Incorporating Data into the National Data Centers

Academic Research Data

The discussion of the IOOS in Chapter 26 points to the importance of collecting data from stable, long-term, calibrated *in situ* and satellite sensors. However, there is also value in capturing more ephemeral observational data, typically collected as a part of research projects. Recipients of federal research grants and contracts are required by law to submit their data to the appropriate national data center within a specified time period. Most oceanographic data must be submitted to the National Oceanographic Data Center or the National Geophysical Data Center. Oceanographic data arising from international programs must also be submitted, according to policies established by the Intergovernmental Oceanographic Data Exchange program. However, there are wide variations among agencies in their enforcement of these requirements and their tracking of compliance. Research data are often not submitted to national databases for years after a project ends, if ever. Strengthened procedures, both domestically and internationally, are urgently needed to provide for the timely inclusion of all ocean data into data centers, and to ensure full and open access to data collected at taxpayers' expense.

Recommendation 28–4. The Committee on Ocean Science, Education, Technology, and Operations (COSETO) should establish and enforce common requirements and deadlines for investigators to submit data acquired during federally funded ocean research projects.

In establishing these requirements, COSETO should:

- *provide incentives to ensure more timely submission of investigator data to the national centers.*

- *require that a certification of data deposit be supplied to investigators who comply with the new regulations and that this certificate be presented before subsequent federal funding is provided.*

Reviewing Classified Data

A significant proportion of all oceanographic data is collected and archived by the Navy. However, these data are generally classified and not available for access by the larger oceanographic community. In 1995, the MEDEA Special Task Force was created to determine the potential for important environmental research based on classified Navy databases, and to prioritize data for declassification. Opportunities were identified for mutually beneficial collaborations between the civilian and naval ocean sciences communities, and approaches were suggested to realize broader national benefits from public investments in data collection and modeling by the Navy.[4] Increased access to data declassified as a result of the one-time MEDEA initiative has been very useful to the oceanographic community. Both scientists and managers can continue to benefit from ongoing declassification of Navy data, particularly bathymetric data critical to improved ocean modeling.

Recommendation 28–5. The U.S. Navy should periodically review and declassify appropriate naval oceanographic data for access by the civilian science community.

MEETING THE CHALLENGES OF A NEW CENTURY

Looking beyond the data management needs for ocean sciences, the environmental challenges of the 21st century will require access to the full spectrum of environmental data. As a robust ocean observing system is created, and as the nation moves toward integrating ocean, climate, atmospheric, and terrestrial monitoring systems within a comprehensive Earth Observing System, both the volume of data and the need to integrate widely varied datasets will continue to grow. At the same time, historical environmental data must continually be preserved to enable long time-series analyses of natural processes that occur over decades, centuries, and millennia. Revolutionary discoveries about the Earth's environment and the ability to better predict its dynamics will result from the use of diverse, long-term, integrated data sets.

Critical improvements in the environmental data management infrastructure at the federal level must be made today and sustained into the future to realize the full benefits of an integrated system. Numerous valuable studies, pilot projects, recommendations, and strategies for improved management of environmental data have been produced over the years. However, the integration of existing environmental data is continually impeded by the lack of a unified interagency strategy and a national financial commitment to a modern, integrated data management system.

Recommendation 28–6. The President should convene an interagency task force to plan for modernizing the national environmental data archiving, assimilation, modeling, and distribution system with the goal of designing an integrated Earth environmental data and information system.

The task force should:

- *be comprised of all federal agencies with environmental data collection responsibilities.*
- *create an environmental data management plan that includes specific cost estimates and phasing requirements to ensure timely implementation and appropriate funding.*

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[1] National Oceanic and Atmospheric Administration. *The Nation's Environmental Data: Treasures at Risk*. A Report to Congress on the Status and Challenges for NOAA's Environmental Data Systems. Washington, DC: U.S. Department of Commerce, 2001.

[2] Ibid.

[3] Office of Naval Research and National Science Foundation. *An Information Technology Infrastructure Plan to Advance Ocean Sciences*. Washington, DC, January 2002.

[4] MEDEA. *Special Task Force Report: Scientific Utility of Naval Environmental Data*. McLean, VA: Mitre Corporation, 1995.

U.S. COMMISSION ON
OCEAN POLICY

PART VIII
THE GLOBAL OCEAN: U.S. PARTICIPATION IN INTERNATIONAL POLICY

Chapter 29:
Advancing International Ocean Science and Policy

The United States has long been a leader in developing and supporting international initiatives vital to the health of the world's oceans and coasts, including arrangements to protect the marine environment, conserve whales and other marine mammals, implement responsible fishing practices, preserve coral reefs, and enhance port security. The nation can best protect and advance its maritime interests by continuing to engage actively in international policymaking, global scientific initiatives and programs to build ocean management capacity in developing nations. In particular, it is imperative that the nation ratify the United Nations Convention on the Law of the Sea, the preeminent legal framework for addressing international ocean issues. Until that step is taken, the United States will not be able to participate directly in the bodies established under the Convention that make decisions on issues of importance to all coastal and seafaring nations.

Acting Globally to Safeguard the Oceans

Just as the well-being of U.S. citizens and the productivity of the U.S. economy depend on the ocean, the same holds true for most other nations. The oceans provide vital food and energy supplies, facilitate waterborne commerce, and create valuable recreational opportunities. It is in America's interest to work with the international community to preserve the productivity and health of the oceans and to secure cooperation among nations everywhere in managing marine assets wisely.

Over the last several decades, we have seen the creation of a comprehensive body of international ocean law and policy, increased attempts at ocean and coastal management by many nations, enhanced scientific understanding of the marine environment, and a proliferation of new actors who participate in ocean governance at the global, regional, and national levels. Despite this rise in activity and scrutiny, resource depletion has continued, conflicts persist over the management of ocean uses, and many countries in the developing world lack the means to effectively manage the marine areas and resources within their jurisdiction.

International ocean challenges should be familiar to U.S. policy makers because parallel problems are found to varying degrees along our own coasts. These include overfishing, pollution, habitat loss, and conflicts among competing users. Virtually every topic covered in this report has a corresponding international dimension, and the proposed solutions are often similar, including an emphasis on sustainability, the adoption of an ecosystem-based management approach, enhanced education and stewardship, better science, smoother intergovernmental cooperation and sufficient funding.

The United States can best influence ocean management globally by enacting and enforcing exemplary policies here at home. However, domestic action alone will not be enough to deal with the many challenges facing the world's oceans and coasts. Solutions at the international level will require broad participation and cooperation, taking into account the interests, rights, and responsibilities of all coastal nations. To this end, the United States must work with other nations to develop institutions and mechanisms to improve all aspects of ocean governance.

Reviewing the Evolution of the International Ocean Regime

As discussed in Chapter 2, the international ocean management regime has evolved from virtually unregulated, open access to a system of well-defined national zones of authority. Beginning in the early 1600s and continuing for almost four centuries, the dominant paradigm for governing the oceans was the principle of freedom of the seas, based on the premise that the oceans were infinite and marine resources inexhaustible. There was nothing, it was assumed, that humans could do to cause irreversible damage to such a vast and bountiful resource.

This view of the oceans began to change dramatically in the middle of the 20th century, when it became apparent that problems of overfishing and pollution threatened ocean assets that had previously been taken for granted. Coastal nations began to claim exclusive jurisdiction over ocean areas and resources off their coasts. Decisions by many nations to claim areas of the ocean as their own soon created a bewildering array of claims regarding the geographic extent of these areas and the powers that could lawfully be exercised within them.

To restore a sense of order and predictability, the international community developed a global ocean regime that specifies the rights and duties of coastal nations in 200-mile exclusive economic zones off their coasts, while maintaining freedoms of navigation essential for security and world trade. This regime also sets forth the collective rights and responsibilities of nations in the use of ocean resources outside areas of national jurisdiction.

Today, a plethora of mechanisms and institutional arrangements exist at the bilateral, regional, and global levels to address ocean-related issues. Many of these arrangements benefit from the participation of nongovernmental organizations, scientists, the private sector, development assistance agencies, and other stakeholders in addition to government representatives.

On June 3, 2003, the leaders of the eight largest industrialized democracies (known as the G-8), issued a joint statement declaring their intention to implement a global action plan for environmental responsibility and sustainable development of the oceans.[1] If carried out, this action plan could serve as a basis for more effective ocean management worldwide.

Developing and Implementing International Policy

The United States has traditionally been a leader in international ocean policymaking and has participated in the development of many international agreements that govern the world's ocean areas and resources. That leadership must be maintained and reinvigorated. The challenges of the 21st century will require improved collaboration among policy makers everywhere to establish ambitious objectives and take the actions necessary to achieve them.

Guiding Principles

The guiding principles for sound ocean management discussed in Chapter 3 of this report are also relevant to U.S. policies in the international arena. These include an emphasis on sustainability, good stewardship, ecosystem-based management, preservation of biodiversity, use of the best available science, and international responsibility. This last principle calls for the United States to act cooperatively with other nations in developing and implementing ocean policy, reflecting the deep connections between U.S. interests and the world's oceans.

In developing and implementing international ocean policy, the United States should:

- Use multilateral approaches, including participation in international forums, to achieve solutions to global ocean issues where coordinated action by many nations is required.
- Provide technical and financial assistance to build ocean science and management capacity in developing nations and small island states.
- Engage in partnerships with nongovernmental organizations, the scientific community, the private sector, regional institutions, and others to combine government with nongovernmental resources and expertise.

The Law of the Sea Convention

For more than two centuries, the United States participated in the formation of customary international ocean law, a set of uniformly applied rules that nations accept as binding. The 1982 United Nations Convention on the Law of the Sea (LOS Convention) codified much of this body of law, and created new rules to address unresolved issues, such as the balance between freedom of navigation and expanding claims of coastal state jurisdiction.

The LOS Convention is, in essence, a "constitution" for the oceans. It provides a comprehensive delineation of the rights, duties, and responsibilities of nations within the territorial sea, exclusive economic zone (EEZ), continental shelf, and high seas. It addresses specific subjects such as marine scientific research, seabed mining, and environmental protection. The Convention also creates institutions for managing ocean issues and provides mechanisms for settling disputes.

The United States is not among the 145 parties to the Convention, despite having been at the forefront of its development. When the Convention was adopted in 1982, the United States and other industrial nations had concerns about the regime established to govern deep seabed mining in areas outside national jurisdiction. To address these concerns, an agreement was reached in 1994 that substantially modified the provisions the United States and others found objectionable.

Today, the Convention enjoys widespread backing within the United States across a broad range of stakeholders in government, industry, environmental groups and academia, and bipartisan support in Congress. There are many compelling reasons for the United States to expeditiously accede to the Convention. International bodies established under the Convention are in the process of making decisions that directly affect important U.S. interests. For example, the Commission on the Limits of the Continental Shelf is considering jurisdictional claims over resources on the continental margin, an area of particular importance to the United States with its broad continental shelf and margin rich in energy resources. Measures to guide the future exploration and exploitation of deep seabed resources under the Convention are also being developed.

The Convention will no doubt continue to evolve. In 2004, the Convention will be open for amendment by its parties for the first time. If the United States is to ensure that its interests as a maritime power and coastal state are protected, it must participate in this process. The best way to do that is to become a party to the Convention, and thereby gain the right to place U.S. representatives on LOS decision-making bodies. Participation in the Convention would also enhance America's prestige and credibility as a leader on global ocean issues.

Recommendation 29–1. The United States should accede to the United Nations Convention on the Law of the Sea.

Other Ocean-related International Agreements

There are many international agreements in addition to the LOS Convention that address either ocean management generally or specific issues such as fisheries regulation, species protection, vessel safety, and coral reefs. Here again, the United States has played a major role in designing and gaining support for many of these agreements, which are briefly summarized in Table 29.1.

Binding international agreements signify a commitment by participating nations to carry out specific actions, often allowing measurable progress to be made in meeting objectives. For example, parties to the International Convention for the Conservation of Atlantic Tunas must abide by catch limits placed on tunas and related species.

Nonbinding agreements can also prove useful in influencing nations to act responsibly. These agreements establish goals toward which nations agree to work and sometimes serve as a preliminary step to binding action. They are often preferable for addressing a problem where scientific uncertainty or temporarily insurmountable economic costs make firmer commitments unobtainable.

Agreements Stemming from the Earth Summit

Several major nonbinding agreements were reached at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro (known as the Earth Summit). This event built on the U.N. Conference on the Human Environment held in Stockholm twenty years previously. The Stockholm conference placed environmental matters on the global agenda for the first time and led to the creation, among other landmark outcomes, of the U.N. Environment Program and of environmental agencies and associated legislation in many countries, including the United States.

At the center of the Earth Summit's agenda was a commitment to advancing sustainable development—the principle that economic development and the environment are inextricably linked and must be addressed together. Summit negotiations were intense, requiring the resolution of differences among developed and developing nations. The Summit was also characterized by the inclusion of an unprecedented number of representatives from nongovernmental organizations. Among the major international agreements forged at the Summit were the Rio Declaration of Principles, the Framework Convention on Climate Change, and Agenda 21—a comprehensive set of international guidelines for achieving sustainable development in all areas, including the oceans and coasts.

Another product of the Earth Summit was the U.N. Convention on Biological Diversity (CBD) which aims to conserve biological diversity worldwide while providing rules for the sustainable use of genetic resources. In 1995, the parties to the CBD issued the Jakarta Mandate, which initiated a marine and coastal resource work program focused on five topics: integrated ocean and coastal area management; ocean and coastal protected areas; sustainable use of ocean and coastal living resources; marine aquaculture; and alien species.

Many coastal nations regulate access by foreign scientists and explorers to genetic resources in waters under their jurisdiction. These nations often seek royalties from the commercialization of these resources, including pharmaceuticals resulting from bioprospecting. Most nations have ratified the CBD but the United States has not, largely because of divergent views regarding the ownership of genetic resources. This reflects a need to balance an interest in legal protection for private biotechnology investors with the rights of sovereign nations to their resources.

Because the United States is not a party to this treaty, the nation cannot directly participate in the development of the CBD regime or in negotiations on protocols, such as the Cartagena Protocol on

Biosafety, which regulates the importation of living modified organisms and thus has important implications for U.S. economic sectors. Other CBD areas of interest to the United States include regulation of the trade of certain species, creation of useful compilations of marine scientific data, and the ability of member nations to negotiate access and collection agreements for scientists.

Recommendation 29–2. The National Ocean Council should coordinate an expedited review and analysis of the ocean-related components of the United Nations Convention on Biological Diversity and recommend to the U.S. Department of State whether, from an ocean perspective, ratification of this treaty would be beneficial to U.S. interests.

Meeting International Obligations

Although the next decade will undoubtedly see new international agreements on ocean issues, the main challenge for the world community will be wider ratification and more effective implementation and enforcement of existing agreements. To achieve their goals, the international organizations charged with carrying out these agreements must also be adequately funded. Every participating nation, including the United States, should fully meet its financial commitments, consistent with the treaty obligations it has accepted.

Collaboration for International Ocean Policy

To lead in the international ocean arena, the United States must maintain a vigorous national discussion of global ocean issues. Enhanced communication, coordination, and collaboration among U.S. government agencies, scientific institutions, the private sector, and other stakeholders will strengthen U.S. performance at international negotiations and enable the nation to be more influential in shaping and executing world ocean policy. Similarly, at the international level, governments, agencies, United Nations bodies, and scientific associations must work closely together to achieve success.

U.S. Coordination

Within the U.S. government, the U.S. Department of State is the lead agency for most ocean-related international negotiations. However, the role of more specialized agencies is extremely important due to the science and resource focus of many multilateral ocean issues. For example, living marine resources are primarily the responsibility of the National Oceanic and Atmospheric Administration. The U.S. Coast Guard generally takes the lead in developing and enforcing vessel safety and environmental protection regulations. The U.S. Environmental Protection Agency does the same in mitigating pollution from land- and water-based sources. And the U.S. Trade Representative has a role in the interface of international trade and ocean policy.

Consistent application of a wide range of expertise is essential both to establish international ocean standards that reflect U.S. interests, and to make certain that subsequent actions by the United States and others are in accordance with those standards. A new mechanism is needed to provide the optimum degree of coordination among U.S. agencies sharing responsibility and knowledge of international ocean issues. Since the early 1970s, various interagency groups have attempted to address these issues, most recently as a subcommittee under the National Security Council's (NSC's) Global Environmental Affairs Policy Coordinating Committee. While the NSC subcommittee should continue to focus on specific security-related issues, the National Ocean Council should establish and oversee an interagency committee charged with responsibility for developing and implementing overall U.S. international ocean policy.

Recommendation 29–3. The National Ocean Council (NOC) should establish and oversee an interagency committee to support the development and implementation of ocean-related international policy.

The international committee of the NOC should:

- *be chaired by the U.S. Department of State.*
- *make recommendations to the Assistant to the President, the Secretary of State, and other agency heads as appropriate, on international ocean policy.*
- *assess the implementation status of ocean-related treaties to which the United States is a party and recommend appropriate actions and funding required to fulfill U.S. treaty obligations.*
- *provide technical assistance to the NOC on international ocean issues.*

International Ocean Governance

Numerous global institutions coordinate the development and implementation of international ocean policy. These include the U.N.'s International Oceanographic Commission (IOC), International Maritime Organization (IMO), Environment Program (UNEP), Food and Agricultural Organization (FAO), and many others. (For a description of these and other international institutions, see Appendix D.)

Enhanced coordination is needed among international ocean governance institutions to avoid the piecemeal, sectoral, and unstructured development of ocean policy. One possible approach is to develop a mechanism for coordinating all U.N. entities that have jurisdiction over ocean and coastal issues. Recent steps in this direction by the U.N. should be encouraged.

Emerging International Management Challenges

Wise management requires good planning and proactive approaches. New ocean-related problems and opportunities are sure to arise as populations grow, technologies improve, and knowledge increases. Several prominent, emerging ocean and coastal management issues, some of which are being discussed on a national scale, also have international dimensions. The challenge is to find appropriate global mechanisms—whether new or existing—to ensure that these emerging issues are dealt with in accordance with sound management principles. A clear international regime is vital to provide consistency and certainty to users, maximize the benefits of these resources, and reduce possible negative environmental impacts. The following examples are just a few of the emerging issues that will require international attention:

- ***Marine protected areas.*** Numerous international agreements support the establishment of protected areas to improve the management of fragile coastal and marine ecosystems. These areas may restrict certain activities depending on the level of protection necessary to sustain particular resources. (For a discussion of marine protected areas, see Chapter 6.) Difficult international decisions loom over the appropriate balance between environmental protection and high seas freedoms.

- ***Polar regions***. Many studies indicate that by mid-century the Earth will probably have substantially less ice cover in polar regions. This may lead to major changes in commercial and military transportation routes, ecosystem conditions, resource exploitation, and social and economic conditions. It is not too soon to begin discussions about the ramifications and appropriate management of burgeoning activities in polar waters.

- ***Carbon sequestration.*** Due to concerns about the rising level of carbon dioxide in the atmosphere, experiments have been conducted to transfer some into the oceans. One method is to inject carbon dioxide directly into deep ocean waters or under the seafloor where it forms frozen gas hydrates. Another approach is to fertilize the surface of the ocean—typically with iron—thereby accelerating the uptake of carbon dioxide by organisms in surface waters. The long-term effectiveness and potential environmental consequences of either approach to ocean sequestration of carbon dioxide remain unknown.

Furthermore, no decision-making process is in place to determine whether or not these activities should be allowed to proceed.

- ***Seamounts.*** Worldwide concerns have been expressed about over-fishing around underwater mountains on the high seas. These ocean features, referred to as seamounts, typically attract robust fish populations that are not subject to the jurisdiction of any country. Without binding international agreements, these populations will quickly succumb to the tragedy of the commons.

Recommendation 29–4. The international committee of the National Ocean Council should assess emerging international ocean-related management challenges and make recommendations for either incorporating these activities under existing management regimes or developing appropriate new ones. The U.S. Department of State should work with the international community to implement these recommendations.

Scientific Input to U.S. Policy Makers

Successful national and international ocean policy depends on sound scientific information. It is essential, therefore, to ensure that U.S. policymakers benefit from timely advice and guidance from the U.S. marine scientific community. This, in turn, requires procedures that both give scientists the opportunity to provide input and policy makers the chance to carefully consider their recommendations.

A 1999 report by the National Research Council introduced the concept of "science for diplomacy" to improve the ability of the State Department to incorporate scientific expertise into the foreign policy process.[2] The State Department has since taken several significant steps to strengthen its scientific capabilities, including the establishment in 2000 of the Office of Science and Technology Advisor to the Secretary of State. Continued progress is needed to increase knowledge and enhance understanding within the department of the complex scientific basis of many international ocean policy issues.

Recommendation 29–5. The U.S. Department of State should improve its integration of ocean-related scientific expertise in policy and program development and implementation.

These improvements can be accomplished by:

- *increasing State Department staff training and awareness of the relevance of scientific considerations to international ocean policy.*
- *increasing scientific support throughout the department to address current and emerging ocean-related issues, particularly through the use of borrowed personnel from resource agencies.*
- *improving mechanisms to facilitate input from the scientific community on complex ocean-related issues.*

Enhancing International Ocean Science

The United States has been a leader in ocean science and research since creation of the U.S. Commission on Fish and Fisheries in 1871. Eleven years later, the 234-foot *USS Albatross* entered service as the first U.S. research vessel built exclusively for fisheries and oceanographic research. On land, major centers of activity included the Woods Hole Oceanographic Institution, which has attracted scientists from around the world for more than a century, and the Scripps Institution of Oceanography, an innovator in marine technology since 1903. Over the last fifty years, dozens of other top-tier U.S. oceanographic institutions have developed. If the United States is to maintain its leadership status, it must build on this tradition by strengthening international scientific partnerships for the purpose of deepening the world's understanding of the oceans.

International Ocean Science Programs

International ocean research is conducted and coordinated by a variety of entities including the U.N. Intergovernmental Oceanographic Commission (IOC), which has sponsored conferences and meetings on an array of topics in this field. These programs include efforts to understand El Niño, the role of the oceans in the global carbon balance, climate variability, and algal blooms. The Scientific Committee on Oceanic Research (SCOR), an interdisciplinary body of the International Council for Science, focuses on large-scale ocean research projects for long-term, complex activities. SCOR also promotes capacity building in developing countries by including scientists from such countries in its working groups and other activities. Other institutions, including the World Meteorological Organization, the U.N. Environment Program and the International Hydrographic Organization, are doing valuable work on climate change, coral reefs, and ocean surveys.

The United States participates in and contributes to collaborative international ocean research both to fulfill our global obligations and because it is in our national interest to do so. The more we know, the better we can protect our long-term stake in healthy and productive oceans.

Recommendation 29–6. The United States should continue to participate in and fund major international ocean science organizations and programs.

The Global Ocean Observing System

An international effort is underway to gain a better understanding of the current state of the world's oceans, and to revolutionize the ability to predict future ocean conditions. When fully realized, the Global Ocean Observing System will use state-of-the-art technology to integrate data streams from satellites and globally-deployed ocean sensors. These data will then be made available in usable form to resource managers, businesses, and the general public. This initiative is part of a larger international effort to create a system that integrates ocean, atmosphere, and terrestrial observations.

The U.S. role in helping to develop a Global Ocean Observing System is closely linked with efforts to improve ocean data collection on a national scale. The U.S. Integrated Ocean Observing System will link the global system to regional ocean observing systems in the United States. The value of developing national and global observing systems is discussed in Chapter 26, as are the needs for continued improvements in scientific and technological infrastructure, and enhanced international cooperation and coordination. Improving international coordination of ocean observations and integrating these observations into the broader suite of atmospheric and terrestrial observations, is a cornerstone of the ongoing effort to strengthen the role of science in international policy-making.

U.S. Scientific Activities Abroad

In the past, marine scientific research was protected as a "freedom of the sea" and largely unregulated outside the territorial sea. However, under the LOS Convention, coastal nations generally can assert greater legal jurisdiction than previously over various types of research conducted in their exclusive economic zones and extended continental shelf. Coastal nations can require researchers to obtain prior approval to conduct research in the nation's waters and to share research data, samples, and results. The extent of the coastal nation's authority depends on the location and purpose of the research (e.g., scientific, archaeological, historical, or economic) and must be exerted in accordance with provisions of the LOS Convention that promote international cooperation in this field. There is variability in the extent to which coastal nations choose to exercise the authority available to them. The United States has chosen, to date, not to assert jurisdiction over U.S. or foreign marine scientific researchers in the U.S. EEZ. This policy is intended to encourage good international relations, and through reciprocity, to benefit the nation's marine scientific community by easing access to foreign waters.

The State Department is the primary federal agency charged with facilitating the international programs and activities of U.S. scientists. Since 1972, the department has processed about 6,000 requests to coastal nations around the world, seeking permission to conduct U.S. oceanographic research in their waters. However, support within the department for facilitating U.S. science abroad has varied over time. While it has improved in recent years, growing interest in marine scientific research will require continued attention to this function.

Strong partnerships between U.S. and foreign scientists facilitate agreement on how international science initiatives should be conducted and how results should be shared. An example of this type of collaborative effort is the Ocean Drilling Program, which is implemented through a memorandum of understanding among the United States and several international partners. Such partnerships can also be used to build scientific capacity in other nations. Collaborations between the United States and Mexico, for example, show the benefits of integrating scientific research with education and training, building and sharing infrastructure, participating mutually in large-scale programs, planning joint events and publications, and developing sources of bi-national funding.[3]

Recommendation 29–7. The U.S. Department of State should offer strong support for U.S. scientists conducting research programs around the world. Existing international partnerships should be strengthened and new partnerships promoted to facilitate the conduct of international research.

Building International Capacity in Ocean Science and Management

Implementation of international ocean policy and improved management of ocean and coastal resources worldwide are affected by the adequacy of the science and management capacity of every coastal nation. Well-trained scientists and high-quality laboratories and equipment in every nation will contribute to the overall understanding of the oceans. Ecosystem-based management can only succeed if all nations with management responsibility for some component of the ecosystem work together to sustain its health.

U. S. Involvement in International Capacity Building Efforts

One area where the United States is helping to build the capacity of other nations to implement ecosystem-based management concerns the impact on the marine environment of land-based sources of marine pollution. That is the focus of the White Water to Blue Water initiative, which is currently developing pilot programs with partners in the Caribbean region. The United States also helps to finance the U.N. Environment Program, which in 2002 launched the Hilltops 2 Oceans (H2O) initiative, with a similar focus, as part of the Global Program of Action for the Protection of the Marine Environment from Land-Based Sources. (For additional discussion of these initiatives, see Chapter 14.)

This report recommends a number of measures aimed at strengthening U.S. ocean and coastal science and management capacity. To maintain progress on a global scale, the United States and other capable nations must also assist coastal nations of more limited means. This assistance can be in the form of funding, human resource development, technology transfer, information sharing, or other advisory and consultative services. To be most effective, assistance should be science-based and developed within the context of an ecosystem-based approach. Efforts should be concentrated on issues that have been identified as particularly critical for the health of an ecosystem or marine species, and have the greatest potential for positive impacts. In most instances, effective capacity-building will require long-term efforts to change detrimental practices and build support for new, sustainable management approaches. These efforts will require a funding commitment sufficient to make the changes needed to preserve or rebuild healthy ecosystems.

Many developing nations are particularly dependent on ocean and coastal resources; however poverty and unhealthy conditions still predominate in many of their coastal communities. U. S. assistance will not only benefit ocean and coastal science and management, but also result in meaningful economic gains to the developing nations, thereby creating goodwill and strengthening U.S. international ties.

Recommendation 29–8. The United States should increase its efforts to enhance long-term ocean science and management capacity in other nations through funding, education and training, technical assistance, and sharing best practices, management techniques, and lessons learned.

Table 29.1. U.S. Participation in International Ocean Agreements

Listed below are a number of ocean-related international treaties and agreements, with a specification of whether the United States is a party. These agreements represent a wide range of international ocean policy issues including fisheries management, species protection, vessel safety, and coral reef preservation. Some of the listed agreements are not formal treaties or conventions; for these, ratification is not applicable.

Agreement Name	Description	Date of Agreement	Date Entered Into Force	Has the U.S. Signed?	Has the U.S. Ratified?
United Nations Convention on the Law of the Sea and related agreements					
United Nations Convention on the Law of the Sea (LOS)	LOS is a comprehensive regime of law and order in the world's oceans and seas. LOS is comprised of 320 articles and nine annexes and governs all aspects of ocean space, such as delimitation, pollution control, scientific research, resource management, technology transfer and dispute settlement.	12/10/82	11/16/94	No	No
Agreement on Part XI of the LOS Convention (Deep Seabed Mining Agreement)	Amends the LOS regime governing the deep seabed. Reflects a shift to more free-market oriented policies. Modifies decision making to reflect political and economic interests and financial contributions of states while retaining the principle that the seabed is the "common heritage of mankind."	07/28/94	07/28/96	Yes	No
Fisheries-related Agreements					
Agreement for the Implementation of the LOS Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (FSA)	The FSA sets out principles for the conservation and management of straddling stocks and highly migratory fish on the high seas and places new regulatory authority in the hands of regional fisheries bodies.	08/04/95	12/11/01	Yes	Yes

Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas	The Compliance Agreement promotes compliance by fishing vessels on the high seas with international conservation and management measures. It requires a party to make all efforts to ensure that vessels flying its flag do not engage in any activity that undermines the conservation or management of biological resources.	11/24/93	04/24/03	Yes	Yes
International Convention for the Conservation of Atlantic Tunas	The International Convention for the Conservation of Atlantic Tunas is an international fishery treaty for the conservation of tunas and tuna-like species in the Atlantic Ocean and its adjacent seas.	05/14/66	03/21/69	Yes	Yes
Marine Environment					
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention)	The London Convention regulates the disposal of waste materials into the sea. It establishes "black- and gray-lists" for wastes, which can be considered for disposal at sea according to the hazard they present to the environment.	12/29/72	08/30/75	Yes	Yes
Protocol to the London Convention	The Protocol to the London Convention is more restrictive than the Convention and in principal part creates a "reverse list," which implies that all dumping is prohibited unless explicitly permitted.	11/08/96	Not in force	Yes	No
International Convention For The Prevention Of Pollution From Ships (MARPOL 1973/1978)	MARPOL is concerned with the prevention of accidental and operational vessel-source pollution. It is implemented through six technical annexes. Annexes I (oil) and II(noxious liquids carried in bulk) are mandatory; Annexes III (harmful substances carried in package form), IV (sewage), V (garbage from ships) and VI (air emissions) are optional.	MARPOL			
			10/02/83	Yes	Yes
		Annexes I and II			
			10/02/83	Yes	Yes
		Annex III			
			07/01/92	Yes	Yes
		Annex IV			
			09/27/03	No	No
		Annex V			
			12/31/88	Yes	Yes
		Annex VI			
			Not in force	Yes	No

Global Plan of Action for the Protection of the Marine Environment from Land-Based Activities (GPA)	The GPA is designed to be a source of conceptual and practical guidance to be drawn upon by national and/or regional authorities in devising and implementing sustained action to prevent, reduce, control and eliminate marine degradation from land-based activities.	11/03/95	Not a treaty	Supported	Not applicable
Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR)	CCAMLR established a Commission with the authority to adopt measures for the conservation of Antarctic marine living resources, including the designation of protected species, open and closed seasons and areas for harvesting, and catch limits.	05/20/80	04/07/82	Yes	Yes
Antarctic Treaty	The Treaty provides that Antarctica shall be used for peaceful purposes only and for scientific investigation and cooperation. It prohibits nuclear explosions and disposal of radioactive waste.	12/01/59	06/23/61	Yes	Yes
Protocol on Environmental Protection to the Antarctic Treaty	The Protocol provides for the comprehensive protection of the Antarctic environment and dependent and associated ecosystems.	10/04/91	01/14/98	Yes	Yes
Declaration on the Establishment of the Arctic Council	The Arctic Council is a high level forum that promotes cooperation, coordination and interaction among Arctic States, with the involvement of Arctic indigenous communities on common issues (except military security) and in particular sustainable development and environmental protection in the Arctic.	09/19/96	Not a treaty	Supported	Not Applicable
Boundary Waters Treaty	The treaty established the International Joint Commission (IJC) between the US and Canada to prevent and resolve disputes relating to the use and quality of the boundary waters (such as the Great Lakes).	01/11/1909	05/05/1910	Yes	Yes
Biodiversity and Wildlife					
International Convention for the Regulation of Whaling (ICRW)	The ICRW establishes the International Whaling Commission (IWC), which regulates commercial and aboriginal subsistence whaling.	12/02/46	11/10/48	Yes	Yes

Convention on Wetlands of International Importance, Especially As Waterfowl Habitat (RAMSAR)	RAMSAR provides the framework for national action and international cooperation for the conservation and wise use of wetlands. There are currently 1368 wetland sites, totaling 120 million hectares (about 296 million acres), included in the system.	02/02/71	12/21/75	Yes	Yes
Convention on International Trade in Endangered Species (CITES)	CITES requires that the import, export, and introduction of listed species has to be authorized through a licensing system.	03/03/73	07/01/75	Yes	Yes
Convention Concerning the Protection of the World Cultural and Natural Heritage	The World Heritage Convention defines the kind of natural or cultural sites which can be considered for inscription on the World Heritage List, and sets out the duties of States Parties in identifying potential sites and their role in protecting and preserving them.	11/23/72	12/17/75	Not Applicable (UNESCO treaties are not opened for signature)	Yes
Convention on Migratory Species of Wild Animals (CMS)	CMS aims to conserve terrestrial, marine, and avian migratory species throughout their range. CMS provides strict protection for the endangered migratory species and encourages further multilateral agreements for the conservation and management of other migratory species.	06/29/79	11/01/83	No	No
Convention on Biological Diversity (CBD)	The CBD aims to promote the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.	06/05/92	12/29/93	Yes	No
Jakarta Mandate	The Jakarta Mandate is a program of action for implementing the CBD in marine areas. It focuses on sustainable use of living resources, integrated marine and coastal area management, protected areas, mariculture and alien species.	01/01/95	Not a treaty	Did not support	Not applicable

Cartagena Protocol on Biosafety	The Protocol seeks to protect biological diversity by establishing procedures for the transboundry movement of living modified organisms. For such organisms destined for intentional introduction into the importing party's environment (i.e., planting), an advance informed agreement procedure is established.	01/29/00	09/11/03	No	No
International Coral Reef Initiative (ICRI)	ICRI is a partnership among nations and organizations seeking to implement international commitments for the benefit of coral reefs and related ecosystems. ICRI was established to stop and reverse the degradation of coral reefs and related ecosystems.	06/02/95	Not a treaty	Supported	Not applicable
Climate Change					
U.N. Framework Convention on Climate Change (UNFCCC)	UNFCCC aims to regulate levels of greenhouse gas concentration in the atmosphere, so as to avoid the occurrence of climate change on a level that would impede sustainable economic development or compromise initiatives in food production.	05/09/92	03/21/94	Yes	Yes
Kyoto Protocol to UNFCCC	The Kyoto Protocol aims to reduce net emissions of certain greenhouse gases (primarily carbon dioxide). Each of the participating developed countries must decide how to meet its respective reduction goal during a five-year period (2008-2012).	12/11/97	Not in force	Yes	No
Small Island Developing States					
Barbados Programme of Action for the Sustainable Development of Small Island Developing States (BPOA)	The BPOA sets forth specific actions and measures to be taken at the national, regional and international levels in support of the sustainable development of Small Island Developing States.	05/06/94	Not a treaty	Supported	Not applicable
Cultural Heritage					
UNESCO Convention for the Protection of the Underwater Cultural Heritage	The Convention affirms that participating States must cooperate in the protection of underwater cultural heritage, that preservation *in situ* shall be the first consideration before allowing any other activities, and that underwater heritage shall not be commercially exploited.	11/02/01	Not in force	Not Applicable (UNESCO treaties are not opened for signature)	No

Trade					
Marrakesh Agreement Establishing the World Trade Organization (WTO)	The WTO provides a global institutional framework for the conduct of trade among nations and oversees development and implementation of multilateral trade agreements such as GATT 1994. The WTO provides a common mechanism for resolving trade disputes, including those that arise due to concerns over the impact of international trade on conservation of marine flora and fauna.	04/15/94	01/01/95	Yes	Yes
Environment and Development					
U.N. Conference on the Human Environment (Stockholm Declaration)	The Stockholm Declaration and accompanying 109-item action plan represented the first effort by the global community to address environmental problems on a comprehensive basis.	06/16/72	Not a treaty	Supported	Not applicable
U.N Conference on Environment and Development (known as the Rio Declaration or UNCED) and **Agenda 21**	The Rio Declaration is a set of 27 principles to guide national and international actions on environment, development, and social issues. Agenda 21 is a forty-chapter action plan across the entire spectrum of environmental, development, and social issues confronting humankind.	06/14/92	Not a treaty	Supported	Not applicable
World Summit on Sustainable Development(known as the Johannesburg Declaration or WSSD) and **Johannesburg Plan of Implementation** (POI)	The Johannesburg Declaration re-affirms international support for and commitment to the Rio principles. The POI asserts that poverty eradication, changing unsustainable patterns of production and consumption, and protecting and managing the natural resource base of economic and social development are overarching objectives of, and essential requirements for, sustainable development, and provides an action plan for implementation of the WSSD outcomes.	09/04/02	Not a treaty	Supported	Not applicable

[1] 2003 G8 Summit. "Marine Environment and Tanker Safety: A G8 Action Plan." <http://www.g8.fr/evian/english/navigation/2003_g8_summit/summit_documents/marine_environment_and_tanker_safety_-_a_g8_action_plan.html> Accessed March 2, 2004.

[2] National Research Council. *The Pervasive Role of Science, Technology, and Health in Foreign Policy*. Washington, DC: National Academy Press, 1999.

[3] National Research Council. *Building Ocean Science Partnerships: The United States and Mexico Working Together*. Washington, DC: National Academy Press, 1999.

PART IX
MOVING AHEAD: IMPLEMENTING A NEW NATIONAL OCEAN POLICY

Chapter 30
Funding Needs and Possible Sources

Better coordination at all levels of government, decisions based on dependable science, an informed and engaged citizenry—these are all important parts of what the U.S. Commission on Ocean Policy sees in its vision of our ocean future. This report contains recommendations aimed at ensuring that the nation's ocean and coastal resources are healthy and sustainable. Significant change, however, does not come without significant investment. This chapter outlines the costs associated with actions needed to improve our ocean policy. It also presents a proposal for meeting those costs through the creation of a new Ocean Policy Trust Fund. Monies for the fund would be generated through resource rents from permitted uses in federal waters, including outer Continental Shelf oil and gas revenues that are not currently committed to other funds. The Fund would support additional responsibilities placed on federal agencies and prevent unfunded mandates to states.

Investing in Change

This report outlines a series of ambitious proposals for improving the use and protection of the nation's oceans and coasts. But meaningful change requires meaningful investments. In the case of the ocean, such investments are easy to justify. As explained in Chapter 1, more than one trillion dollars, or one-tenth of the nation's annual gross domestic product, is generated each year within communities immediately adjacent to the coast. By including the economic contribution from all coastal watershed counties, that number jumps to around five trillion dollars, or fully one half of our nation's economy. Those contributions are threatened by continued degradation of ocean and coastal environments and resources.

From its beginning, this Commission pledged to be clear about the costs of its recommendations. In keeping with that approach, the final report will include a complete accounting of the startup, short-term, and continuing costs associated with each issue area, including an analysis of federal, state, and local budget implications to the extent possible. For now, this draft report provides estimates of overall ***new*** federal spending requirements, based on the preliminary recommendations summarized in Chapter 31.

Mindful of intense budgetary pressures at both federal and state levels—and sensitive to the hardship associated with unfunded federal mandates—the Commission also set out to identify appropriate sources of revenue to cover the full cost of its recommendations. A logical, responsible funding strategy is outlined below, to be developed further in the final report.

Acknowledging the Cost of Taking Action

Based on the contents of this preliminary report, the total additional cost to the federal government of implementing the Commission's recommendations will be approximately $1.3 billion in the first year of implementation, $2.4 billion in the second year, and $3.2 billion per year in ongoing costs thereafter (Table 30.1)—a very reasonable investment in view of the value generated by ocean and coastal industries.

Just as this report addresses a multitude of issues, from clean water to marine commerce and beaches to ballast water, final cost calculations will cover a similar broad range. Although a detailed breakdown of costs must await finalization of the Commission's report, including input from the Governors and others, a few special investments are worth pointing out.

Table 30.1. Estimated Cost of Recommendations in the Preliminary Report of the U.S. Commission on Ocean Policy

Recommended Activity	Location in Report	First Year Cost (millions)	Second Year Cost (millions)	Continuing Annual Cost (millions)
National Ocean Council and related elements	Ch. 4	$1	$2	$2
Ocean Education	Ch. 8	$7	$251	$246
IOOS	Ch. 26	$290	$312	$652
Ocean Science and Exploration	Ch. 25	$230	$395	$760
Federal Support for State Actions	Ch.24	$500	$750	$1,000
Other Recommendations	throughout	$245	$708	$532
TOTAL		**$1,273**	**$2,418**	**$3,192**

The National Ocean Policy Framework

The centerpiece of the Commission's recommendations for improving federal leadership for oceans and coasts is the National Ocean Policy Framework. In particular, Chapter 4 calls for the immediate establishment of a National Ocean Council (NOC) in the Executive Office of the President. The NOC would be chaired by an Assistant to the President, advised by a nonfederal Presidential Council of Advisors on Ocean Policy, and supported by a small Office of Ocean Policy. The cost of establishing these entities, to provide better coordination and management of the oceans and move toward an ecosystem-based management approach, will be approximately one million dollars in the first year, and two million dollars per year subsequently.

The costs associated with other elements of the framework, including regional ocean councils, regional ocean information programs, and federal agency restructuring, will be discussed in greater detail in the final report.

Ocean Education

High quality, lifelong ocean education is essential to improve science literacy and instill a widespread sense of stewardship for the oceans. A number of concrete steps to achieve these goals are recommended in Chapter 8, including support for curriculum development and other formal and informal educational programs, expansion of the Centers for Ocean Sciences Education Excellence, creation of a national ocean education coordinating office, and much more. The first year startup cost is estimated at $7 million, with significant investments of around $250 million in subsequent years.

The Integrated Ocean Observing System

To achieve well-informed, science-based ocean and coastal management with an ecosystem focus, no tool is more important than the national Integrated Ocean Observing System (IOOS). A fully operating IOOS will provide critical information for protecting human lives and property from marine hazards, improving ocean health, predicting global climate change, enhancing national and homeland security, and providing for the protection, sustainable use, and enjoyment of ocean resources. Just as the nation and its citizens have come to rely on an extensive system of weather observations, routine ocean observations and forecasts will be viewed as a necessity before long as their value becomes evident. The direct benefits to industry, property, and human life alone easily justify the initial investment. The first year cost of implementing the IOOS is estimated at $290 million, rising over a period of five years to an ongoing annual cost of $650 million.

Ocean Science and Exploration

Science and exploration are closely related endeavors. In simple terms, explorers discover new places, species, and phenomena which scientists then study, unravel, and explain. Prominent observers have pointed out that we now know more about the moon than the bottom of the ocean, despite the huge potential for answering fundamental questions about our planet and discovering new forms of life right here at home. The gradual shrinking of ocean science funding, from 7 percent of the federal research budget in the1970s to only 3.5 percent today, must be reversed to address the nation's need for better coastal and ocean information and allow managers to make well-informed decisions. The Commission recommends a doubling of the current federal ocean and coastal research budget plus a significant investment in well-planned, technologically sophisticated ocean exploration expeditions. The cost for sparking this new era of ocean discovery—and reaping the tangible human benefits—will be around $230 million in the first year, rising to a sustained, but still modest level of $760 million a year.

Using Revenue from Ocean Uses for Improved Ocean Management

Various parts of this report discuss federal revenues that are being or may be generated from offshore activities. Chapter 6 introduces the concept of resource rents, the economic value being derived from the use or development of a natural resource. If the resource is publicly-owned, its availability to the private sector should be contingent on a reasonable return of some portion of the rent to taxpayers. A proposal for a new Marine Aquaculture Management Framework is put forward in Chapter 22 and includes a recommendation for a revenue collection process that recognizes the public interest in the ocean space and resources used for aquaculture operations in federal waters. Chapter 24 covers nonliving resources in federal waters and discusses the substantial revenues flowing into land conservation and historic preservation funds and the general U.S. Treasury from outer Continental Shelf (OCS) oil and gas development. It also addresses the possible emergence of offshore renewable energy resources, including the growing interest in wind farms, and the need for a comprehensive regime to coherently manage such technologies and ensure a fair return to the public for the use of marine resources.

The Federal Ocean Family

The nexus between activities in federal waters and the programmatic, regulatory, and management responsibilities they engender is clear. From the need for better coordination at the federal level requiring a new National Ocean Policy Framework; to the increased emphasis on better science and information, including the critical data that will be provided by the IOOS; to the obvious necessity for the nation's citizens to develop an ocean stewardship ethic through the strengthening of our marine education institutions, the full panoply of actions at the federal governmental level that this report recommends is connected, at least in part, to the activities, current and emerging, in our adjacent sea. Chapter 7 is unambiguous in stating that solidifying the National Oceanic and Atmospheric Administration as the nation's lead civilian ocean agency involves increasing its responsibilities in a number of areas. Other agencies may also be similarly affected. As noted, these changes require new, meaningful investments in addition to the current budget baselines of federal agencies with ocean functions.

State Partners in Ocean and Coastal Policy Development and Implementation: Federal Support

States (including local, territorial, and tribal governments) have a critically important role to play in the new National Ocean Policy Framework. Through the legal authorities that states exercise for land and water use policies within their own sovereign borders and submerged lands, to the additional marine programs added by Congress over the years, to the areas identified in this report as being critical in bringing states into more of a partnership role with the federal government, a comprehensive national ocean policy prominently includes the states.

Under the new ocean policy, states will have particularly important functions to carry out in areas such as coastal development, water quality, education, natural hazards planning, fishery management, habitat conservation, and much more. The establishment of regional ocean councils, a central element in the new National Ocean Policy Framework, will depend on interest and leadership at the state level. States should also participate as full partners in the design and implementation of regional ocean observing systems and their integration into the national IOOS. These and many other opportunities for states to contribute to a more integrated, effective ocean policy are consolidated and briefly discussed in Chapter 31. The Commission is also well aware that additional responsibilities will require additional revenues and that the states simply cannot take on any unfunded mandates as a result of the implementation of the comprehensive ocean policy recommended herein.

New Revenues for the Federal Ocean Family and State Government Partners: The Ocean Policy Trust Fund

The critical nature of the nation's oceans assets and the challenges faced in managing them make it clear that the time has come to establish an Ocean Policy Trust Fund in the U.S. Treasury to assist federal agencies and state governments in carrying out the comprehensive ocean policy recommended by this Commission.

The Fund would be composed of federal revenues from OCS oil and gas development, other than those currently committed to other funds, and would also include any future rents from permitted uses of federal waters. The Land and Water Conservation Fund, the National Historic Preservation Fund, and the OCS oil and gas revenues given to coastal states from the three mile area seaward of their submerged lands would not be affected. Only after the revenues for those programs were provided in accordance with law, would the OCS monies be deposited into the Ocean Policy Trust Fund.

Chapter 24 documents that approximately $5 billion is generated annually from the various forms of OCS oil and gas revenues. Protecting the three programs noted above would remove about $1 billion from eligible revenues. Thus, some $4 billion of oil and gas money would remain available for the Ocean Policy Trust Fund for each year under current projections. While it is not possible to estimate the amount of revenue that might be produced by newer emerging uses in federal waters nor when they may actually be generated, such resource rents should also be deposited in the Fund.

Chapter 24 also includes a detailed discussion of the economic inequities between onshore and offshore federal land leasing and development programs and recommends that a portion of the revenues received from the extraction of nonrenewable offshore resources be granted to states for the conservation and sustainable development of renewable ocean and coastal resources. OCS oil and gas producing states will need a larger portion of such revenues to address the impacts in their states from the energy activity on adjacent federal offshore lands.

Recommendation 30-1. Congress, with input from the National Ocean Council (NOC), should establish an Ocean Policy Trust Fund in the U.S. Treasury. The Fund should be composed of unallocated federal revenues from outer Continental Shelf (OCS) oil and gas leasing and development, and resource rents assessed on new activities in federal waters. Trust Fund monies should be dispersed to coastal states and federal agencies to support improved ocean and coastal management commensurate with the nation's new coordinated and comprehensive national ocean policy.

The Ocean Policy Trust Fund should:

- *distribute $500 million in the first year, increasing to $1.0 billion in the third and subsequent years, among all coastal states, with a larger share going to OCS producing states (for offshore energy impacts). The funds should be used for the conservation and sustainable development of renewable ocean and coastal resources, including tasks that fall to the states as a result of Commission recommendations.*
- *distribute the remainder of the funds among the NOC agencies to address additional activities assigned to them by Commission recommendations, according to an allocation determined by the NOC.*
- *be used to supplement—not replace—existing appropriations for ocean and coastal programs and to fund new or expanded duties.*

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CHAPTER 31: SUMMARY OF RECOMMENDATIONS

The Oceans Act of 2000 charged the U.S. Commission on Ocean Policy with carrying out the first comprehensive review of ocean-related issues and laws in more than thirty years. The Commission took up that charge, presenting almost 200 recommendations throughout this preliminary report that will move the nation toward a more coordinated and comprehensive ocean policy. This chapter provides summaries of those recommendations, categorized by the organization or individual charged with carrying out the proposed action. To see the actual text of each recommendation, along with more detailed elaborations and context, readers should consult the appropriate report chapter.

GUIDING PRINCIPLES

As described in Chapter 3, the Commission's work was guided by a set of fundamental principles. These principles underlie all the recommendations and should form the basis of a comprehensive national ocean policy:

- *Sustainability:* Ocean policy should be designed to meet the needs of the present generation without compromising the ability of future generations to meet their needs.

- *Stewardship:* The principle of stewardship applies both to the government and to every citizen. The U.S. government holds ocean and coastal resources in the public trust—a special responsibility that necessitates balancing different uses of those resources for the continued benefit of all Americans. Just as important, every member of the public should recognize the value of the oceans and coasts, supporting appropriate policies and acting responsibly while minimizing negative environmental impacts.

- *Ocean–Land–Atmosphere Connections:* Ocean policies should be based on the recognition that the oceans, land, and atmosphere are inextricably intertwined and that actions that affect one Earth system component are likely to affect another.

- *Ecosystem-based Management:* U.S. ocean and coastal resources should be managed to reflect the relationships among all ecosystem components, including humans and nonhuman species and the environments in which they live. Applying this principle will require defining relevant geographic management areas based on ecosystem, rather than political, boundaries.

- *Multiple Use Management:* The many potentially beneficial uses of ocean and coastal resources should be acknowledged and managed in a way that balances competing uses, while preserving and protecting the overall integrity of the ocean and coastal environment.

- *Preservation of Marine Biodiversity:* Downward trends in marine biodiversity should be reversed where they exist, with a desired end of maintaining or recovering natural levels of biological diversity and ecosystem services.

- *Best Available Science and Information:* Ocean policy decisions should be based on the best available understanding of the natural, social, and economic processes that affect ocean and coastal environments. Decision makers should be able to obtain and understand quality science and information in a way that facilitates successful management of the ocean and coastal resources.

- *Adaptive Management:* Ocean management programs should be designed to meet clear goals and provide new information to continually improve the scientific basis for future management. Periodic reevaluation of the goals and effectiveness of management measures, and incorporation of new information in implementing future management, are essential.

- *Understandable Laws and Clear Decisions:* Laws governing uses of ocean and coastal resources should be clear, coordinated, and accessible to the nation's citizens to facilitate compliance. Policy decisions and the reasoning behind them should also be clear and available to all interested parties.

- *Participatory Governance:* Governance of ocean uses should ensure widespread participation by all citizens on issues that affect them.

- *Timeliness:* Ocean governance systems should operate with as much efficiency and predictability as possible.

- *Accountability:* Decision makers and members of the public should be accountable for the actions they take that affect ocean and coastal resources.

- *International Responsibility:* The United States should act cooperatively with other nations in developing and implementing international ocean policy, reflecting the deep connections between U.S. interests and the global ocean.

The Commission's recommendations embody these principles, and their full implementation will lead the nation toward a future where the benefits of the oceans and coasts are fully realized and the problems plaguing these areas are minimized.

Creating a Strong Role for States

Based on the charge of the Oceans Act of 2000, the Commission has recommended actions for a coordinated and comprehensive national ocean policy on all government levels—including state and local—and has called for enhanced partnerships among federal agencies and state and local stakeholders. The Commission sees a central role for states in ocean and coastal management and identifies many opportunities for them to contribute to an integrated national ocean policy. The Presidential Council of Advisors on Ocean Policy, a high-level advisory body to be appointed by the President, should serve as an important formal structure for input from nonfederal individuals and organizations, including governors of coastal states, additional state, territorial, tribal, and local government representatives, and others.

Important areas for state involvement include:

- formal and informal ocean education at all levels, including outreach to underrepresented and underserved communities.
- creation of regional ocean councils to help coordinate federal, state, tribal, and local planning and action, and of regional ocean information programs to supply the information needed to support an ecosystem-based approach.
- improved management of coastal areas, including incorporation of coastal watersheds, to achieve better control of nonpoint sources of pollution, growth management, natural hazards mitigation, marine

transportation planning, regional sediment management, and identification of priority habitats for conservation and restoration.

- development of a prioritized, comprehensive plan for upgrading the nation's aging and inadequate wastewater and drinking water infrastructure, including improved stormwater management.
- coordination of a national water quality monitoring network and creation of useful products based on the monitoring data.
- planning for early detection, prompt notification, and rapid response to marine invasive species.
- prevention of marine debris, in part through public outreach and education.
- management of commercial and recreational fish stocks and sustainable aquaculture operations.
- protection of corals and coral reefs.
- development of a coordinated offshore management regime, including the design and implementation of marine protected areas.
- development of renewable and nonrenewable ocean energy sources, including attention to their environmental and socioeconomic impacts.

Another area where state input will be essential is the development of ocean observations and science to support policy decisions. States will need to communicate their information needs and priorities as part of the creation of a national strategy for basic and applied ocean science and technology, including the social science and economic research needed to understand the human dimensions and economic value of the oceans and coasts. States should also participate as full partners in the design and implementation of regional observing systems and their integration into the national Integrated Ocean Observing System.

Many of the recommendations listed below explicitly call for federal entities to work with the states and the nonfederal Presidential Council of Advisors on Ocean Policy. But even where it is left unsaid, the importance of state input and action in moving the nation toward an ecosystem-based management approach for the ocean is assumed.

Recommendation Summaries

The following sections summarize all of the Commission recommendations, sorted according to the various organizations and individuals who should take action. Although recommendations are categorized by the primary actor, often another organization or individual is directed to help accomplish the objective. Although these summaries capture the major message of each recommendation, the reader must examine the appropriate report chapter to find the context, background discussion, precise recommendation language, and further details about implementation.

The summary recommendations in this chapter are organized as follows:

I. Recommendations to Congress

Recommendation 4–1. Congress should establish a National Ocean Council, and a nonfederal Presidential Council of Advisors on Ocean Policy, within the Executive Office of the President to provide enhanced federal leadership and coordination for the ocean and coasts. While Congress works to establish these components in law, the President should begin immediately to implement an integrated national ocean policy by creating them through an Executive Order, and by appointing an Assistant to the President to chair the Council.

Recommendation 4–6. Congress should establish an Office of Ocean Policy to support the Assistant to the President, the National Ocean Council (NOC), and the Presidential Council of Advisors on Ocean Policy. To provide immediate staff support, the President should include an Office of Ocean Policy in the Executive Order that creates the Council.

Recommendation 4–7. Congress, working with the National Ocean Council (NOC), should amend the National Oceanographic Partnership Act (NOPA) to integrate ocean observing, operations, facilities, and education into its marine research mission. A strengthened and enhanced National Ocean Research Leadership Council should be redesignated as the Committee on Ocean Science, Education, Technology, and Operations (COSETO). NOPA amendments should specify that COSETO reports to the NOC and is chaired by the director of the Office of Science and Technology Policy.

Recommendation 5–2. Congress should establish regional ocean information programs throughout the nation to improve coordination and set regional priorities for research, data collection, science-based information products, and outreach activities in support of improved ocean and coastal management. The regional ocean information programs should be established immediately, independent of the voluntary, and potentially more complicated, process of establishing regional ocean councils.

Recommendation 5–5. Congress should establish regional boards to administer the regional ocean information programs. Each regional board should include a broad range of stakeholders, develop a regional plan to be submitted to the National Ocean Council, and oversee the regional ocean observing systems. Program priorities should be carried out primarily through a grants process.

Recommendation 6–1. Congress, working with the National Ocean Council (NOC), should ensure that each current and foreseeable use of federal waters is administered by a lead federal agency. The lead agency should coordinate with other federal agencies with applicable authorities and ensure full consideration of the public interest. Pending congressional action, the NOC should designate interim lead agencies to oversee new offshore activities.

Recommendation 6–2. Congress, working with the National Ocean Council and regional ocean councils, should establish an ecosystem-based offshore management regime that sets forth guiding principles for the balanced coordination of all offshore uses. It should recognize the need, where appropriate, for comprehensive single-purpose ocean governance structures that are fully integrated with, and based on the principles of the new offshore management regime. The regime should include a process for incorporating new and emerging activities and a policy that a reasonable portion of the resource rent derived from such activities is returned to the public.

Recommendation 7–1. Congress should pass an organic act that codifies the establishment and missions of the National Oceanic and Atmospheric Administration (NOAA). The act should ensure that NOAA's structure is consistent with the principles of ecosystem-based management and with its three primary functions: assessment, prediction, and operations; resource management; and research and education.

Recommendation 7–4. Congress should authorize the President to propose structural reorganization of federal departments and agencies, subject to expedited Congressional approval. The legislation should preclude Congress from amending the President's proposal and require a vote on the proposal within a fixed time period after submission of the plan by the President.

Recommendation 8–2. Congress should provide funding for the operation of a new National Ocean Council (NOC) Office on Ocean Education (Ocean.ED), and for implementation of related programs, as a line item in the National Oceanic and Atmospheric Administration (NOAA) budget, to be spent at the direction of the NOC. NOAA should develop a streamlined process for distributing Ocean.ED funds to other federal and nonfederal entities as approved by the NOC.

Recommendation 9–1. Congress should reauthorize the Coastal Zone Management Act to strengthen the planning and coordination capabilities of coastal states and enable them to incorporate a coastal watershed focus and more effectively manage growth. Amendments should include requirements for resource assessments, the development of measurable goals and performance measures, improved program evaluations, incentives for good performance and disincentives for inaction, and expanded boundaries that include coastal watersheds.

Recommendation 9–2. Congress should consolidate area-based coastal management programs in a strengthened National Oceanic and Atmospheric Administration (NOAA), capitalizing on the strengths of each program. At a minimum, this consolidation should include the Coastal Zone Management, National Estuarine Research Reserve System, and National Marine Sanctuary programs currently administered by NOAA and additional programs administered by other agencies, including the Coastal Barrier Resources System, the National Estuary Program, and the U.S. Fish and Wildlife Service Coastal Program.

Recommendation 9–4. Congress should amend the Coastal Zone Management Act, the Clean Water Act, and other federal laws where appropriate, to provide better financial, technical, and institutional support for watershed initiatives. Amendments should include appropriate incentives and flexibility for local variability. The National Ocean Council should develop guidance concerning the purposes, structures, stakeholder composition, and performance of watershed initiatives.

Recommendation 10–4. Congress should increase financial and technical assistance to state and local entities for developing hazards mitigation plans consistent with requirements of the Federal Emergency Management Agency (FEMA). The National Ocean Council should identify opportunities for linking federal hazards-related financial and infrastructure support with completion of FEMA-approved state and local hazards mitigation plans.

Recommendation 11–1. Congress should amend the Coastal Zone Management Act to authorize a dedicated coastal and estuarine land conservation program. To achieve this, each state coastal zone management program should identify priority coastal habitats and develop a plan for establishing partnerships among willing landowners for conservation purposes.

Recommendation 11–3. Congress should amend relevant legislation to allow federal agencies greater discretion in using a portion of habitat conservation and restoration funds for related assessments, monitoring, research, and education.

Recommendation 12–4. The U.S. Army Corps of Engineers (USACE), National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, and U.S. Geological Survey should develop a strategy for improved assessment, monitoring, research, and technology development to enhance sediment management. Congress should modify its current authorization and funding processes to encourage USACE to monitor outcomes from past projects and study the cumulative, regional impacts of its activities within coastal watersheds and ecosystems.

Recommendation 13–1. Congress should designate the U.S. Department of Transportation (DOT) as the lead federal agency for planning and oversight of the marine transportation system and DOT should submit regular reports on the condition and future needs of the system. The National Ocean Council should identify overlapping functions in other federal agencies and make recommendations concerning the advisability of transferring those functions to DOT.

Recommendation 13–2. Congress should codify the Interagency Committee for the Marine Transportation System and place it under the oversight of the National Ocean Council. The Committee should improve coordination among participants in the U.S. marine transportation system and promote integration with other modes of transportation and with other ocean and coastal uses and activities.

Recommendation 14–9. To improve and strengthen federal efforts to address nonpoint source pollution, Congress should amend the Clean Water Act to move the National Oceanic and Atmospheric Administration's enforceable nonpoint source pollution program, created under Section 6217 of the Coastal Zone Act Reauthorization Amendments, to become a part of the U.S. Environmental Protection Agency's incentive-based program, created under Section 319 of the Clean Water Act.

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.

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.

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 several elements: 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.

Recommendation 16–8. Congress should provide incentives for boat owners to install improved treatment devices and should increase support for building 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.

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

Recommendation 19–1. Congress should amend the Magnuson–Stevens Fishery Conservation and Management Act and related statutes to require Regional Fishery Management Councils (RFMCs) and interstate fisheries commissions to rely on their Scientific and Statistical Committees (SSCs), incorporating SSC findings and advice into the decision-making process. In keeping with this stronger role, SSC members should meet more stringent scientific and conflict of interest requirements, and receive compensation.

Recommendation 19–9. Congress should increase support for an expanded, regionally-based cooperative research program in the National Oceanic and Atmospheric Administration (NOAA) that coordinates and funds collaborative projects among scientists and commercial and recreational fishermen. NOAA should develop a process for external evaluation and ranking of all cooperative research proposals to ensure the most worthwhile projects are funded, the most capable performers are undertaking the research, and the information produced is both scientifically credible and useful to managers.

Recommendation 19–10. Congress should develop new statutory authority, similar to the Atlantic Coastal Fisheries Cooperative Management Act, to support and empower the Gulf States and Pacific States Fisheries Management Commissions. All interstate management plans should adhere to the national standards in the Magnuson–Stevens Fishery Conservation and Management Act and the federal guidelines implementing these standards. States should participate in development of the guidelines to ensure they are relevant to interstate plans.

Recommendation 19–11. Where a fish stock crosses administrative boundaries, Congress should assign clear fishery management jurisdiction and authority. For each fishery management plan, a state, Regional Fishery Management Council, interstate fisheries commission, or the National Oceanic and Atmospheric Administration should be established as the lead authority. That designation should be based primarily on the proportion of catch associated with each management authority. However, once designated, management authority should not shift based on annual changes in landings.

Recommendation 19–12. Congress should amend the Magnuson–Stevens Fishery Conservation and Management Act to require governors to submit a broad slate of candidates for each vacancy of an appointed Regional Fishery Management Council seat. The slate should include at least two representatives each from the commercial fishing industry, the recreational fishing sector, and the general public.

Recommendation 19–13. Congress should give the Administrator of the National Oceanic and Atmospheric Administration responsibility for appointing Regional Fishery Management Council members with the goal of creating councils that are knowledgeable, fair, and reflect a broad range of interests.

Recommendation 19–15. Congress should amend the Magnuson–Stevens Fishery Conservation and Management Act to affirm that fishery managers are authorized to institute dedicated access privileges. Congress should direct the National Marine Fisheries Service to issue national guidelines for dedicated access privileges that allow for regional flexibility in implementation. Every federal, interstate, and state fishery management entity should consider the potential benefits of adopting such programs.

Recommendation 19–16. Congress should repeal the Fisheries Finance Program (formerly the Fishing Vessel Obligation Guarantee Program), the Capital Construction Fund, and other programs that encourage overcapitalization in fisheries. The National Oceanic and Atmospheric Administration should implement programs to permanently reduce fishing capacity to sustainable levels.

Recommendation 19–17. Congress should increase support for Joint Enforcement Agreements to implement cooperative fisheries enforcement programs between the National Marine Fisheries Service and state marine enforcement agencies. The U.S. Coast Guard should be included as an important participant in such agreements.

Recommendation 20–1. Congress should amend the Marine Mammal Protection Act to require the Marine Mammal Commission, while remaining independent, to coordinate with all relevant federal agencies through the National Ocean Council (NOC). The NOC should consider whether there is a need for similar oversight bodies for other marine animals whose populations are at risk.

Recommendation 20–2. Congress should amend the Marine Mammal Protection Act to place the protection of all marine mammals within the jurisdiction of the National Oceanic and Atmospheric Administration.

Recommendation 20–4. Congress should amend the Marine Mammal Protection Act to require the National Oceanic and Atmospheric Administration to more clearly specify categories of activities that are allowed without a permit, those that require a permit, and those that are prohibited.

Recommendation 20–5. Congress should amend the Marine Mammal Protection Act to revise the definition of harassment to cover only activities that meaningfully disrupt behaviors that are significant to the survival and reproduction of marine mammals.

Recommendation 20–8. Congress should increase support for research into ocean acoustics and the potential impacts of noise on marine mammals. This funding should be distributed across several agencies, including the National Science Foundation, U.S. Geological Survey, and Minerals Management Service, to decrease the reliance on U.S. Navy research in this area. The research programs should be well coordinated across the government and examine a range of issues relating to noise generated by scientific, commercial, and operational activities.

Recommendation 21–1. Congress should pass a Coral Protection and Management Act that covers research, protection, and restoration of coral ecosystems. This legislation should provide support for mapping, monitoring, and research primarily through the National Oceanic and Atmospheric Administration and the U.S. Coral Reef Task Force.

Recommendation 21–2. Congress should codify and strengthen the U.S. Coral Reef Task Force, placing it under the National Ocean Council. The task force should be strengthened by expanding its responsibilities to include both warm and cold water coral communities and by adding the U.S. Department of Energy and the U.S. Army Corps of Engineers as members. The task force should coordinate the development of regional ecosystem-based plans to address the impacts of nonpoint source pollution, fishing, and other activities on coral resources.

Recommendation 22–1. Congress should amend the National Aquaculture Act to create an Office of Sustainable Marine Aquaculture in the National Oceanic and Atmospheric Administration (NOAA) and designate NOAA as the lead federal agency for implementing a national policy for environmentally and economically sustainable marine aquaculture.

Recommendation 22–3. Congress should increase support for expanded marine aquaculture research, development, training, extension, and technology transfer programs in the National Oceanic and Atmospheric Administration (NOAA). NOAA's new Office of Sustainable Marine Aquaculture should set priorities for the research and technology programs, in close collaboration with academic, business, and other stakeholders.

Recommendation 23–4. Congress should establish a national, multi-agency Oceans and Human Health Initiative to coordinate, direct, and fund research and monitoring programs in this area.

Recommendation 24–1. Congress, with input from the National Ocean Council, should ensure that a portion of the revenues that the federal government receives from the leasing and extraction of outer Continental Shelf (OCS) oil and gas is invested in the sustainable development and conservation of renewable ocean and coastal resources through grants to all coastal states. States off whose coasts OCS oil and gas is produced should receive a larger share of such portion to compensate them for the costs of addressing the environmental and socioeconomic impacts of energy activity in adjacent federal waters.

Recommendation 24–5. Congress, with input from the National Ocean Council, should enact legislation providing for the comprehensive management of offshore renewable energy development as part of a coordinated offshore management regime.

Recommendation 25–1. Congress should double the federal ocean and coastal research budget over the next five years, from the 2004 level of approximately $650 million to $1.3 billion per year. A portion of these new funds should be used to support research directed by the regional information collection programs, enlarge the National Sea Grant College Program, and support other high priority research areas described throughout this report.

Recommendation 25–4. Congress should support a greatly expanded national ocean exploration program. The National Oceanic and Atmospheric Administration and the National Science Foundation should be designated as the lead agencies, with additional involvement from the U.S. Geological Survey and the U.S. Navy's Office of Naval Research. Public outreach and education should be integral components of the program.

Recommendation 26–3. Congress should amend the National Oceanographic Partnership Act to formally establish Ocean.US, with a budget appropriate to carry out its mission. Ocean.US should report to the National Ocean Council's (NOC's) Committee on Ocean Science, Education, Technology, and Operations. Congress should make Ocean.US funding a line item within the National Oceanic and Atmospheric Administration's budget, to be spent subject to NOC approval.

Recommendation 26–8. Congress should transfer the National Aeronautics and Space Administration's (NASA's) Earth environmental observing satellites, along with associated resources, to the National Oceanic and Atmospheric Administration (NOAA) to achieve continued operations. NOAA and NASA should work together to ensure the smooth transition of each Earth environmental observing satellite after its launch.

Recommendation 26–9. Congress should fund the Integrated Ocean Observing System (IOOS) as a line item in the National Oceanic and Atmospheric Administration (NOAA) budget, to be spent subject to National Ocean Council direction and approval. IOOS funds should be appropriated without fiscal year limitation. NOAA should develop a streamlined process for distributing IOOS funds to other federal and nonfederal partners.

Recommendation 27–4. Congress should establish a modernization fund for critical ocean infrastructure and technology needs. Spending priorities should be based on the National Ocean Council's ocean and coastal infrastructure and technology strategy.

Recommendation 28–1. Congress should amend the National Oceanographic Partnership Act to establish a federal interagency planning organization for ocean and coastal data and information management to be called Ocean.IT. Ocean.IT should consist of representatives from all federal agencies involved in ocean data and information management, be supported by a small office, and report to the National Ocean Council's Committee on Ocean Science, Education, Technology, and Operations.

Recommendation 30-1. Congress, with input from the National Ocean Council, should establish an Ocean Policy Trust Fund in the U.S. Treasury. The Fund should be composed of unallocated federal revenues from outer Continental Shelf oil and gas leasing and development, and resource rents assessed on new activities in federal waters. Trust Fund monies should be dispersed to coastal states and federal agencies to support improved ocean and coastal management. This new source of funds should be used to supplement—not replace—existing appropriations for ocean and coastal programs and to fund new or expanded duties.

II. Recommendations to the Executive Branch Leadership

A. The President

Recommendation 4–1. Congress should establish a National Ocean Council, and a nonfederal Presidential Council of Advisors on Ocean Policy, within the Executive Office of the President to provide enhanced federal leadership and coordination for the ocean and coasts. While Congress works to establish these components in law, the President should begin immediately to implement an integrated national ocean policy by creating them through an Executive Order, and by appointing an Assistant to the President to chair the Council.

Recommendation 4–5. The Presidential Council of Advisors on Ocean Policy, a formal structure for input from individuals and organizations outside the federal government, should advise the President on ocean and coastal policy matters. The President should appoint to the Council a representative selection of nonfederal individuals who are knowledgeable about, and experienced in, ocean and coastal issues.

Recommendation 4–6. Congress should establish an Office of Ocean Policy to support the Assistant to the President, the National Ocean Council (NOC), and the Presidential Council of Advisors on Ocean Policy. To provide immediate staff support, the President should include an Office of Ocean Policy in the Executive Order that creates the Council.

Recommendation 4–11. The President, through an Executive Order, should direct federal agencies with ocean- and coastal-related functions to immediately improve their regional coordination, as a precursor to federal reorganization around common regional boundaries and the eventual establishment of regional ocean councils. As part of this process, federal agencies should collaborate with regional, state, territorial, tribal, and local governments and nongovernmental parties to identify major issues of concern in each region.

Recommendation 5–4. The Council on Environmental Quality should revise its National Environmental Policy Act guidelines to require that environmental impact statements for proposed ocean- and coastal-related activities take into account any available regional ecosystem assessments developed under the oversight of the regional ocean information programs.

Recommendation 7–2. The President should instruct the Office of Management and Budget (OMB) to review the National Oceanic and Atmospheric Administration budget within OMB's Natural Resources Programs, along with the budgets of the U.S. Departments of Agriculture, Energy, and the Interior, the U.S. Environmental Protection Agency, the National Science Foundation, the National Aeronautics and Space Administration, and the U.S. Army Corps of Engineers' Directorate of Civil Works.

Recommendation 7–5. Following the establishment of the National Ocean Council and the Presidential Council of Advisors on Ocean Policy, strengthening of the National Oceanic and Atmospheric Administration, and consolidation of similar federal ocean and coastal programs, the President should propose to Congress a reorganization of the federal government that recognizes the links among all the resources of the sea, land, and air and establishes a structure for more unified, ecosystem-based management of natural resources.

Recommendation 28–6. The President should convene an interagency task force to plan for modernizing the national environmental data archiving, assimilation, modeling, and distribution system with the goal of designing an integrated Earth environmental data and information system.

B. National Ocean Council

Recommendation 4–2. The National Ocean Council (NOC) should provide high-level attention to ocean and coastal issues, develop and guide the implementation of appropriate national goals and policies, and coordinate the many federal departments and agencies with ocean and coastal responsibilities. The NOC should be chaired by an Assistant to the President and composed of cabinet secretaries of departments and directors of independent agencies with relevant ocean- and coastal-related responsibilities.

Recommendation 4–3. The National Ocean Council (NOC) should adopt the principle of ecosystem-based management and assist federal agencies in moving toward an ecosystem-based management approach.

Recommendation 4–8. The National Ocean Council (NOC) should establish a Committee on Ocean Resource Management to better integrate the resource management activities of ocean-related agencies. This committee should oversee and coordinate the work of existing ocean and coastal interagency efforts, recommend the creation of new topical task forces as needed, and coordinate with government-wide environmental and natural resource efforts that have important ocean components. The Committee on Ocean Resource Management should be chaired by the chair of the Council on Environmental Quality and should include undersecretaries and assistant secretaries of departments and agencies that are members of the NOC.

Recommendation 4–9. The National Ocean Council should review all existing ocean-related councils and commissions and make recommendations about their ongoing utility and reporting structure.

Recommendation 4–10. The National Ocean Council should develop a flexible and voluntary process for the creation of regional ocean councils working closely with Congress, the Presidential Council of Advisors on Ocean Policy, state, territorial, tribal, and local leaders, and representatives from the private sector, nongovernmental organizations, and academia.

Recommendation 5–6. The National Ocean Council should ensure that adequate support is provided for both the research and observing components of the regional ocean information programs.

Recommendation 6–1. Congress, working with the National Ocean Council (NOC), should ensure that each current and foreseeable use of federal waters is administered by a lead federal agency. The lead agency should coordinate with other federal agencies with applicable authorities and ensure full consideration of the public interest. Pending congressional action, the NOC should designate interim lead agencies to oversee new offshore activities.

Recommendation 6–3. The National Ocean Council should develop national goals and guidelines leading to a uniform process for the effective design and implementation of marine protected areas. Marine protected area designations should be based on the best available scientific information and these areas should be periodically assessed, monitored, and modified to ensure continuing ecological and socioeconomic effectiveness.

Recommendation 8–1. The National Ocean Council should establish a national ocean education office, to be called Ocean.ED, under its Committee on Ocean Science, Education, Technology, and Operations to coordinate federal efforts, enhance educational achievement in natural and social sciences, and strengthen ocean awareness.

Recommendation 8–5. The National Ocean Council (NOC), working with the National Science Foundation, should relocate and expand the Centers for Ocean Science Education Excellence within the NOC structure as a program to be organized, overseen, and funded through Ocean.ED.

Recommendation 9–3. The National Ocean Council should recommend changes to federal funding and infrastructure programs to discourage inappropriate growth in fragile or hazard-prone coastal areas and ensure consistency with national, regional, and state goals aimed at achieving economically and environmentally sustainable development.

Recommendation 9–4. Congress should amend the Coastal Zone Management Act, the Clean Water Act, and other federal laws where appropriate, to provide better financial, technical, and institutional support for watershed initiatives. Amendments should include appropriate incentives and flexibility for local variability. The National Ocean Council should develop guidance concerning the purposes, structures, stakeholder composition, and performance of watershed initiatives.

Recommendation 10–1. The National Ocean Council should review and recommend changes to the U.S. Army Corps of Engineers' Civil Works Program to ensure valid, peer-reviewed cost-benefit analyses of coastal projects, provide greater transparency to the public, enforce requirements for mitigating the impacts of coastal projects, and coordinate such projects with broader coastal planning efforts.

Recommendation 10–2. The National Ocean Council should establish a task force of representatives from state and local governments and appropriate federal agencies, with the Federal Emergency Management Agency in the lead, to improve the collection and usability of hazards-related data.

Recommendation 10–3. The National Ocean Council should recommend changes in the National Flood Insurance Program to establish clear disincentives against building in coastal high-hazard zones, enforce measures that reduce vulnerability to natural hazards, and create enforceable mechanisms to direct development away from undeveloped floodplains and erosion zones.

Recommendation 10–4. Congress should increase financial and technical assistance to state and local entities for developing hazards mitigation plans consistent with requirements of the Federal Emergency Management Agency (FEMA). The National Ocean Council should identify opportunities for linking federal hazards-related financial and infrastructure support with completion of FEMA-approved state and local hazards mitigation plans.

Recommendation 11–2. The National Ocean Council should develop national goals for ocean and coastal habitat conservation and restoration efforts and should ensure coordination among all related federal activities. The regional ocean councils and regional ocean information programs should determine habitat conservation and restoration needs and set regional goals and priorities that are consistent with the national goals.

Recommendation 11–4. The National Ocean Council should coordinate development of a comprehensive wetlands protection program that is linked to coastal habitat and watershed management efforts, and should make specific recommendations for the integration of the Clean Water Act Section 404 wetlands permitting process into that broader management approach.

Recommendation 12–1. The National Ocean Council should develop a national strategy for managing sediment on a regional basis, taking into account both economic and ecosystem needs. The strategy should accomplish several objectives: consider adverse impacts on marine environments due to agriculture, dredging, pollutant discharges, and other activities that affect sediment flows or quality; ensure involvement of port managers, coastal planners, and other stakeholders in watershed planning; and require that ecosystem-based management principles serve as the foundation for permitting activities that affect sediment.

Recommendation 13–1. Congress should designate the U.S. Department of Transportation (DOT) as the lead federal agency for planning and oversight of the marine transportation system and DOT should submit regular reports on the condition and future needs of the system. The National Ocean Council should identify overlapping functions in other federal agencies and make recommendations concerning the advisability of transferring those functions to DOT.

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.

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 providing them with adequate technical, institutional, and financial support.

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 coastal and ocean management needs.

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

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.

Recommendation 17–5. The National Ocean Council should review, coordinate, and streamline the current proliferation of federal, regional, and state programs for managing marine invasive species. 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.

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. Research and monitoring should focus on gathering baseline taxonomic information, identifying invasive pathogens and vectors of introduction, understanding the human dimensions behind species introductions, and developing new options for minimizing invasions.

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, monitoring and identification, research, and partnerships with local government, community groups, and industry.

Recommendation 19–26. The National Ocean Council's (NOC's) international committee, which is charged with supporting the development and implementation of ocean-related international policy, should initiate a process to determine the most effective methods of encouraging other nations to implement the United Nations Food and Agriculture Organization's Code of Conduct for Responsible Fisheries and other Plans of Action, and provide its findings to the U.S. Department of State and the NOC.

Recommendation 20–1. Congress should amend the Marine Mammal Protection Act to require the Marine Mammal Commission, while remaining independent, to coordinate with all relevant federal agencies through the National Ocean Council (NOC). The NOC should consider whether there is a need for similar oversight bodies for other marine animals whose populations are at risk.

Recommendation 20–3. The National Ocean Council should improve coordination between the National Marine Fisheries Service and U.S. Fish and Wildlife Service with respect to the implementation of the Endangered Species Act, particularly for anadromous species or when land-based activities have significant impacts on marine species.

Recommendation 20–6. The National Marine Fisheries Service and the U.S. Fish and Wildlife Service should implement programmatic permitting for activities that affect marine mammals, wherever possible. More resource intensive case-by-case permitting should be reserved for unique activities or where circumstances indicate a greater likelihood of harm to marine mammals. The National Ocean Council should create an interagency team to recommend activities appropriate for programmatic permitting, those that are inappropriate, and those that are potentially appropriate pending additional scientific information. Enforcement efforts should also be strengthened and the adequacy of penalties reviewed.

Recommendation 24–4. The National Ocean Council (NOC), working with the U.S. Department of Energy and other appropriate entities, should review the status of methane hydrates research and development and seek to determine whether methane hydrates can contribute significantly to meeting the nation's long-term energy needs. If such contribution looks promising, the NOC should determine how much the current investment in methane hydrates research and development efforts should be increased, and whether a comprehensive management regime for private industry access to methane hydrates deposits is needed.

Recommendation 25–2. The National Ocean Council should develop a national ocean research strategy that reflects a long-term vision, promotes advances in basic and applied ocean science and technology, and guides relevant agencies in developing ten-year science plans and budgets.

Recommendation 25–3. The National Ocean Council should create a national program for social science and economic research to examine the human dimensions and economic value of the nation's oceans and coasts and encourage ocean research agencies to include socioeconomic research as part of their efforts. An operational socioeconomic research and assessment function should be designated within the National Oceanic and Atmospheric Administration.

Recommendation 25–5. The National Ocean Council should coordinate federal resource assessment, mapping, and charting activities with the goal of creating standardized, easily accessible national maps that incorporate living and nonliving marine resource data along with bathymetry, topography, and other natural features.

Recommendation 26–1. The National Ocean Council should make development and implementation of a sustained, national Integrated Ocean Observing System a central focus of its leadership and coordination role.

Recommendation 26–10. The National Ocean Council should oversee coordination of the Integrated Ocean Observing System with other existing and planned terrestrial, watershed, atmospheric, and biological observation and information collection systems, with the ultimate goal of developing a national Earth Observing System.

Recommendation 26–11. The National Ocean Council (NOC) should promote international coordination and capacity building in the field of global ocean observations. The NOC should lead the U.S. implementation of the 2003 Declaration on Earth Observing, advocate full, open, and meaningful data access policies, and contribute technological expertise to ensure access by all nations.

Recommendation 27–1. The National Ocean Council should develop a national ocean and coastal infrastructure and technology strategy, including funding and implementation requirements.

Recommendation 27–3. The National Ocean Council should update the assessment of U.S. ocean and coastal infrastructure and technology, including federal, state, academic, and private assets and associated human resource needs, every five years.

Recommendation 28–4. The National Ocean Council should establish and enforce common requirements and deadlines for investigators to submit data acquired during federally funded ocean research projects.

Recommendation 29–2. The National Ocean Council should coordinate an expedited review and analysis of the ocean-related components of the United Nations Convention on Biological Diversity and recommend to the U.S. Department of State whether, from an ocean perspective, ratification of this treaty would be beneficial to U.S. interests.

Recommendation 29–3. The National Ocean Council (NOC) should establish and oversee an interagency committee to support the development and implementation of ocean-related international policy. This committee should be chaired by the U.S. Department of State, make recommendations to the Assistant to the President and the Secretary of State on international ocean policy, and provide technical assistance to the NOC on international ocean issues.

Recommendation 29–4. The National Ocean Council's international committee should assess emerging international ocean-related management challenges and make recommendations for either incorporating these activities under existing management regimes or developing appropriate new ones. The U.S. Department of State should work with the international community to implement these recommendations.

1. NOC Committee on Ocean Science, Education, Technology, and Operations

i) Office on Ocean Education (Ocean.ED)

Recommendation 8–4. Ocean.ED should lead the development of a framework for evaluating and assessing the effectiveness of ocean-related education programs, ocean-based K–12 professional development programs, best practices for incorporating ocean-based examples into K–12 education, and public education programs.

Recommendation 8–6. Ocean.ED, working with state and local education authorities and the research community, should coordinate the development and adoption of ocean-related materials and examples that meet existing education standards.

Recommendation 8–7. Ocean.ED, working with academic institutions and local school districts, should help establish stronger and more effective relationships between the research and education communities to expand professional development opportunities for teachers and teacher educators. The National Oceanic and Atmospheric Administration, National Science Foundation, the U.S. Navy, and National Aeronautics and Space Administration should support these efforts by providing secure and stable funding.

Recommendation 8–8. Ocean.ED should promote partnerships among school districts, institutions of higher learning, aquariums, science centers, museums, and private laboratories to develop more opportunities for students to explore the marine environment, both through virtual means and hands-on field, laboratory, and at-sea experiences. Ocean.ED should ensure that ocean-based educational programs and materials acknowledge cultural differences and other aspects of human diversity, resulting in programs that expose students and teachers from all cultures and backgrounds to ocean issues.

Recommendation 8–10. Ocean.ED should guide and promote the development of the nation's ocean-related workforce.

Recommendation 8–11. The National Oceanic and Atmospheric Administration and the U.S. Department of Labor should establish a national ocean workforce database and compile an annual report for the National Ocean Council on trends in ocean-related human resource development and needs. This effort should include an information clearinghouse to facilitate career decisions, provide access to career guidance, and enable employers, guidance counselors, and others to develop effective strategies to attract students to ocean-related careers. Ocean.ED should organize an ocean workforce summit every five years to address the alignment of ocean education with workforce needs.

Recommendation 8–15. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should encourage and increase the participation of traditionally underrepresented and underserved groups in the ocean-related workforce. Ocean.ED should facilitate collaboration between these agencies and institutions of higher learning to ensure that the appropriate mix of programs and opportunities exists to provide underrepresented and underserved groups ample access to and support for pursuing ocean-related graduate education.

Recommendation 8–16. Ocean.ED, working with other appropriate entities, should enhance existing and establish new mechanisms for developing and delivering relevant, accessible information and outreach programs to enhance community education.

ii) Office on Ocean Observing (Ocean.US)

Recommendation 26–2. Ocean.US, with National Ocean Council (NOC) oversight, should be responsible for planning the national Integrated Ocean Observing System (IOOS). The National Oceanic and Atmospheric

Administration should be the lead federal agency for implementing and operating the IOOS, with extensive interagency coordination and subject to NOC approval.

Recommendation 26–4. Ocean.US should proactively seek input from coastal and ocean communities to build cross-sector support for the national Integrated Ocean Observing System and develop consensus about operational requirements.

Recommendation 26–5. Ocean.US, with National Ocean Council oversight, should develop a set of core variables to be collected by all components of the national Integrated Ocean Observing System. The core variables should include appropriate biological, chemical, geological, and physical variables, and should be agreed on by the regional ocean information programs.

Recommendation 26–6. Ocean.US should recommend priorities and long-term plans for space-based missions as an essential component of the national Integrated Ocean Observing System.

iii) Office on Ocean Information (Ocean.IT)

Recommendation 28–3. The interagency group for ocean information management, Ocean.IT, should work with developers of the National Virtual Ocean Data System and other innovative data management systems to implement a federally-supported system for accessing ocean and coastal data both within and outside the national data centers.

C. Assistant to the President

Recommendation 4–4. A designated Assistant to the President should provide leadership and support for national ocean and coastal policy. The Assistant to the President should chair the National Ocean Council (NOC), co-chair the Presidential Council of Advisors on Ocean Policy, and lead NOC efforts to coordinate federal agency actions and involve regional, state, and local stakeholders.

Recommendation 7–3. The Assistant to the President, with advice from the National Ocean Council and the Presidential Council of Advisors on Ocean Policy, should review federal ocean, coastal, and atmospheric programs, and recommend opportunities for consolidation of similar functions.

D. Presidential Council of Advisors on Ocean Policy

Recommendation 4–5. The Presidential Council of Advisors on Ocean Policy, a formal structure for input from individuals and organizations outside the federal government, should advise the President on ocean and coastal policy matters. This Council should be composed of a representative selection of nonfederal individuals appointed by the President who are knowledgeable about, and experienced in, ocean and coastal issues.

III. Recommendations to Federal Government Agencies

A. U.S. Department of Commerce, National Oceanic and Atmospheric Administration

Recommendation 8–2. Congress should provide funding for the operation of a new National Ocean Council (NOC) Office on Ocean Education (Ocean.ED), and for implementation of related programs, as a line item in the National Oceanic and Atmospheric Administration (NOAA) budget, to be spent at the direction of the NOC. NOAA should develop a streamlined process for distributing Ocean.ED funds to other federal and nonfederal entities as approved by the NOC.

Recommendation 8–3. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should strengthen their support of both formal and informal ocean-related education, including appropriate assessments and evaluation of these efforts.

Recommendation 8–7. Ocean.ED, working with academic institutions and local school districts, should help establish stronger and more effective relationships between the research and education communities to expand professional development opportunities for teachers and teacher educators. The National Oceanic and Atmospheric Administration, National Science Foundation, the U.S. Navy, and National Aeronautics and Space Administration should support these efforts by providing secure and stable funding.

Recommendation 8–9. The National Oceanic and Atmospheric Administration, National Science Foundation, and Office of Naval Research should support colleges and universities in promoting introductory marine science courses to expose students, including non-science majors, to these subjects.

Recommendation 8–11. The National Oceanic and Atmospheric Administration and the U.S. Department of Labor should establish a national ocean workforce database and compile an annual report for the National Ocean Council on trends in ocean-related human resource development and needs. This effort should include an information clearinghouse to facilitate career decisions, provide access to career guidance, and enable employers, guidance counselors, and others to develop effective strategies to attract students to ocean-related careers. Ocean.ED should organize an ocean workforce summit every five years to address the alignment of ocean education with workforce needs.

Recommendation 8–12. The National Oceanic and Atmospheric Administration should establish a national ocean education and training program, patterned after the National Institutes of Health model, within its Office of Education and Sustainable Development to provide diverse, innovative ocean-related education opportunities at the undergraduate, graduate, and postdoctoral levels.

Recommendation 8–15. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should encourage and increase the participation of traditionally underrepresented and underserved groups in the ocean-related workforce. Ocean.ED should facilitate collaboration between these agencies and institutions of higher learning to ensure that the appropriate mix of programs and opportunities exists to provide underrepresented and underserved groups ample access to and support for pursuing ocean-related graduate education.

Recommendation 12–4. The U.S. Army Corps of Engineers (USACE), National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, and U.S. Geological Survey should develop a strategy for improved assessment, monitoring, research, and technology development to enhance sediment management. Congress should modify its current authorization and funding processes to encourage USACE to monitor outcomes from past projects and study the cumulative, regional impacts of its activities within coastal watersheds and ecosystems.

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.

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.

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.

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.

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

Recommendation 18–3. The U.S. Department of State and the 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.

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.

Recommendation 19–9. Congress should increase support for an expanded, regionally-based cooperative research program in the National Oceanic and Atmospheric Administration (NOAA) that coordinates and funds collaborative projects among scientists and commercial and recreational fishermen. NOAA should develop a process for external evaluation and ranking of all cooperative research proposals to ensure the most worthwhile projects are funded, the most capable performers are undertaking the research, and the information produced is both scientifically credible and useful to managers.

Recommendation 19–16. Congress should repeal the Fisheries Finance Program (formerly the Fishing Vessel Obligation Guarantee Program), the Capital Construction Fund, and other programs that encourage overcapitalization in fisheries. The National Oceanic and Atmospheric Administration should implement programs to permanently reduce fishing capacity to sustainable levels.

Recommendation 19–25. The National Oceanic and Atmospheric Administration, working with the U.S. Fish and Wildlife Service and the U.S. Department of State, should design a National Plan of Action for the United States that implements, and is consistent with, the International Plans of Action adopted by the United Nations Food and Agriculture Organization and its 1995 Code of Conduct for Responsible Fisheries. This National Plan should stress the importance of reducing bycatch of endangered species and marine mammals.

Recommendation 20–7. The National Oceanic and Atmospheric Administration and the U.S. Department of the Interior should promote an expanded research, technology, and engineering program, coordinated through the National Ocean Council, to examine and mitigate the effects of human activities on marine mammals and endangered species.

Recommendation 21–3. The National Oceanic and Atmospheric Administration should develop national standards—and promote international standards—to ensure that coral reef resources that are collected, imported, or marketed are harvested in a sustainable manner. The U.S. Department of State should implement incentive programs to encourage international compliance with these standards.

Recommendation 22–2. The National Oceanic and Atmospheric Administration's new Office of Sustainable Marine Aquaculture should be responsible for developing a comprehensive, environmentally-sound permitting, leasing, and regulatory program for marine aquaculture.

Recommendation 22–3. Congress should increase funding for expanded marine aquaculture research, development, training, extension, and technology transfer programs in the National Oceanic and Atmospheric Administration (NOAA). NOAA's new Office of Sustainable Marine Aquaculture should set priorities for the research and technology programs, in close collaboration with academic, business, and other stakeholders.

Recommendation 23–1. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support expanded research and development efforts to encourage multidisciplinary studies of the evolution, ecology, chemistry, and molecular biology of marine species, discover potential marine bioproducts, and develop practical compounds, through both competitively awarded grants and support of federally designated centers.

Recommendation 23–2. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support expanded research efforts in marine microbiology and virology.

Recommendation 23–3. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support the development and implementation of improved methods for monitoring and identifying pathogens and chemical toxins in ocean waters and organisms.

Recommendation 24–3. The National Oceanic and Atmospheric Administration, working with the Minerals Management Service and the offshore oil and gas industry, should establish a partnership that will allow the use of industry resources, including pipelines, platforms, vessels, and research and monitoring programs, as part of the Integrated Ocean Observing System.

Recommendation 26–2. Ocean.US, with National Ocean Council (NOC) oversight, should be responsible for planning the national Integrated Ocean Observing System (IOOS). The National Oceanic and Atmospheric Administration should be the lead federal agency for implementing and operating the IOOS, with extensive interagency coordination and subject to NOC approval.

Recommendation 26–7. The National Oceanic and Atmospheric Administration, National Science Foundation (NSF), the U.S. Navy, and National Aeronautics and Space Administration should require investigators who receive federal funding related to ocean research observatories, including the NSF Ocean Observatories Initiative, to develop plans for transferring new technologies to an operational mode in the Integrated Ocean Observing System.

Recommendation 26–8. Congress should transfer the National Aeronautics and Space Administration's (NASA's) Earth environmental observing satellites, along with associated resources, to the National Oceanic and Atmospheric Administration (NOAA) to achieve continued operations. NOAA and NASA should work together to ensure the smooth transition of each Earth environmental observing satellite after its launch.

Recommendation 26–9. Congress should fund the Integrated Ocean Observing System (IOOS) as a line item in the National Oceanic and Atmospheric Administration (NOAA) budget, to be spent subject to National Ocean Council direction and approval. IOOS funds should be appropriated without fiscal year limitation. NOAA should develop a streamlined process for distributing IOOS funds to other federal and nonfederal partners.

Recommendation 27–2. The National Oceanic and Atmospheric Administration should create an Office of Technology to expedite the transition of experimental technologies into operational applications. This office should work closely with academic institutions, the regional ocean information programs, the National Science Foundation, the U.S. Navy, the National Aeronautics and Space Administration, and other relevant agencies to achieve its mission.

Recommendation 27–5. The National Oceanic and Atmospheric Administration should establish national virtual marine technology centers to provide coordinated access, through electronic means, to cutting-edge, large-scale research technologies.

Recommendation 28–2. The National Oceanic and Atmospheric Administration and the U.S. Navy should establish a joint ocean and coastal information management and communications program to generate information products relevant to national, regional, state, and local needs on an operational basis.

1. National Marine Fisheries Service

Recommendation 19–4. The National Marine Fisheries Service, working with the Regional Fishery Management Councils and the interstate fisheries commissions, should develop a process for independent review of the scientific information generated by the Scientific and Statistical Committees in all regions. This process should include three procedures: a standard review, an enhanced review, and an expedited review.

Recommendation 19–5. Each Regional Fishery Management Council should set a deadline for its Scientific and Statistical Committee (SSC) to determine allowable biological catch. If the SSC does not meet that deadline, the National Marine Fisheries Service Regional Science Director should set the allowable biological catch for that fishery.

Recommendation 19–7. The Regional Fishery Management Councils and their Scientific and Statistical Committees should develop an annual, prioritized list of management information needs and provide it to the National Marine Fisheries Service (NMFS). NMFS should incorporate these needs to the maximum extent possible in designing its research, analysis, and data collection programs.

Recommendation 19–8. The National Marine Fisheries Service, working with states and interstate fisheries commissions, should require all saltwater anglers to purchase licenses to improve in-season data collection on recreational fishing. Priority should be given to fisheries in which recreational fishing is responsible for a large part of the catch, or in which recreational fishermen regularly exceed their allocated quota.

Recommendation 19–14. The National Marine Fisheries Service (NMFS) should require all newly appointed Regional Fishery Management Council (RFMC) members to complete a training course within six months of their appointment. NMFS should contract with an external organization to develop and implement this training course. Members who have not completed the training may participate in RFMC meetings, but may not vote.

Recommendation 19–18. The National Marine Fisheries Service and the U.S. Coast Guard should strengthen cooperative enforcement efforts at the national level by developing a unified strategic plan for fisheries enforcement that includes significantly increased joint training, and at the regional and local levels, by developing a stronger and more consistent process for sharing information and coordinating enforcement.

Recommendation 19–19. The National Marine Fisheries Service, working with the Regional Fishery Management Councils, the U.S. Coast Guard, and other appropriate entities, should maximize the use of the Vessel Monitoring System (VMS) for fishery-related activities by: requiring that VMS with two-way communication capability be phased in for all commercial fishing vessels receiving permits under federal fishery plans, including party and charter boats that carry recreational fishermen, incorporating VMS features that assist personnel in monitoring and responding to potential violations, and identifying state fisheries that could significantly benefit from VMS implementation.

Recommendation 19–21. The National Marine Fisheries Service (NMFS) should change the designation of essential fish habitat from a species-by-species to a multispecies approach and, ultimately, to an ecosystem-based approach. The approach should draw upon existing efforts to identify important habitats and locate optimum-sized areas to protect vulnerable life-history stages of commercially important species. NMFS should work with other management entities to protect essential fish habitat when such areas fall outside their jurisdiction.

Recommendation 19–22. The National Marine Fisheries Service (NMFS) and Regional Fishery Management Councils should develop regional bycatch reduction plans that address broad ecosystem impacts of bycatch. Implementation of these plans will require NMFS to expand current efforts to collect data on bycatch, not only of commercially important species, but on all species captured by commercial and recreational fishermen. The selective use of observers should remain an important component of these efforts.

Recommendation 20–6. The National Marine Fisheries Service and the U.S. Fish and Wildlife Service should implement programmatic permitting for activities that affect marine mammals, wherever possible. More resource intensive case-by-case permitting should be reserved for unique activities or where circumstances indicate a greater likelihood of harm to marine mammals. The National Ocean Council should create an interagency team to recommend activities appropriate for programmatic permitting, those that are inappropriate, and those that are potentially appropriate pending additional scientific information. Enforcement efforts should also be strengthened and the adequacy of penalties reviewed.

B. U.S. Environmental Protection Agency

Recommendation 12–4. The U.S. Army Corps of Engineers (USACE), National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, and U.S. Geological Survey should develop a strategy for improved assessment, monitoring, research, and technology development to enhance sediment management. Congress should modify its current authorization and funding processes to encourage USACE to monitor outcomes from past projects and study the cumulative, regional impacts of its activities within coastal watersheds and ecosystems.

Recommendation 12–5. The U.S. Environmental Protection Agency, working with other appropriate entities, should develop a coordinated strategy for assessment, monitoring, and research to better understand how contaminated sediment is created and transported, and to develop technologies for better prevention, safer dredging of such sediment, and more effective treatment after it is recovered.

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.

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.

Recommendation 14–3. 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. 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.

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.

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.

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.

Recommendation 14–11. 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. 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.

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.

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.

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 15–3. 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.

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.

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.

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 16–9. 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.

Recommendation 16–10. The United States should ratify Annex VI of the International Convention on the Prevention of Pollution from Ships and work for adoption by the International Maritime Organization of even 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 designating certain U.S. ocean and coastal areas with impaired air quality as Annex VI Sulfur Oxide Emission Control Areas.

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.

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.

C. U.S. Department of Defense

1. U.S. Navy

Recommendation 8–7. Ocean.ED (the National Ocean Council's office of education) working with academic institutions and local school districts, should help establish stronger and more effective relationships between the research and education communities to expand professional development opportunities for teachers and teacher educators. The National Oceanic and Atmospheric Administration, National Science Foundation, the U.S. Navy, and National Aeronautics and Space Administration should support these efforts by providing secure and stable funding.

Recommendation 26–7. The National Oceanic and Atmospheric Administration, National Science Foundation (NSF), the U.S. Navy, and National Aeronautics and Space Administration should require investigators who receive federal funding related to ocean research observatories, including the NSF Ocean Observatories Initiative, to develop plans for transferring new technologies to an operational mode in the Integrated Ocean Observing System.

Recommendation 28–2. The National Oceanic and Atmospheric Administration and the U.S. Navy should establish a joint ocean and coastal information management and communications program to generate information products relevant to national, regional, state, and local needs on an operational basis.

Recommendation 28–5. The U.S. Navy should periodically review and declassify appropriate naval oceanographic data for access by the civilian science community.

i) Office of Naval Research

Recommendation 8–3. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should strengthen their support of both formal and informal ocean-related education, including appropriate assessments and evaluation of these efforts.

Recommendation 8–9. The National Oceanic and Atmospheric Administration, National Science Foundation, and Office of Naval Research should support colleges and universities in promoting introductory marine science courses to expose students, including non-science majors, to these subjects.

Recommendation 8–14. The Office of Naval Research (ONR) should reinvigorate its support of graduate education in ocean sciences and engineering. This could be partly accomplished by increasing the number of ocean-related awards made under ONR's National Defense Science and Engineering Graduate Fellowship Program.

Recommendation 8–15. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should encourage and increase the participation of traditionally underrepresented and underserved groups in the ocean-related workforce. Ocean.ED, the National Ocean Council's office of education, should facilitate collaboration between these agencies and institutions of higher learning to ensure that the appropriate mix of programs and opportunities exists to provide underrepresented and underserved groups ample access to and support for pursuing ocean-related graduate education.

2. U.S. Army Corps of Engineers

Recommendation 12–2. The U.S. Army Corps of Engineers should ensure that its selection of the least-cost disposal option for dredging projects reflects a more accurate accounting of the full range of economic and environmental costs and benefits for options that reuse dredged materials, as well as for other disposal methods.

Recommendation 12–4. The U.S. Army Corps of Engineers (USACE), National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, and U.S. Geological Survey should develop a strategy for improved assessment, monitoring, research, and technology development to enhance sediment management. Congress should modify its current authorization and funding processes to encourage USACE to monitor outcomes from past projects and study the cumulative, regional impacts of its activities within coastal watersheds and ecosystems.

D. U.S. Department of Homeland Security, U.S. Coast Guard

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.

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.

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.

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.

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.

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.

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.

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.

Recommendation 19–18. The National Marine Fisheries Service and the U.S. Coast Guard should strengthen cooperative enforcement efforts at the national level by developing a unified strategic plan for fisheries enforcement that includes significantly increased joint training, and at the regional and local levels, by developing a stronger and more consistent process for sharing information and coordinating enforcement.

Recommendation 19–20. The U.S. Coast Guard should be the lead organization in managing the integration of a fishery Vessel Monitoring System (VMS) database into the larger maritime operations database and should work with the National Marine Fisheries Service to ensure effective use of VMS data for monitoring and enforcement.

E. National Science Foundation

Recommendation 8–3. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should strengthen their support of both formal and informal ocean-related education, including appropriate assessments and evaluation of these efforts.

Recommendation 8–7. Ocean.ED, working with academic institutions and local school districts, should help establish stronger and more effective relationships between the research and education communities to expand professional development opportunities for teachers and teacher educators. The National Oceanic and Atmospheric Administration, National Science Foundation, the U.S. Navy, and National Aeronautics and Space Administration should support these efforts by providing secure and stable funding.

Recommendation 8–9. The National Oceanic and Atmospheric Administration, National Science Foundation, and Office of Naval Research should support colleges and universities in promoting introductory marine science courses to expose students, including non-science majors, to these subjects.

Recommendation 8–13. The National Science Foundation's Directorates of Geosciences, Biological Sciences, and Education and Human Resources should develop cooperative programs to provide diverse educational opportunities at the undergraduate, graduate, and postdoctoral levels in a range of ocean-related fields.

Recommendation 8–15. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should encourage and increase the participation of traditionally underrepresented and underserved groups in the ocean-related workforce. Ocean.ED should facilitate collaboration between these agencies and institutions of higher learning to ensure that the appropriate mix of programs and opportunities exists to provide underrepresented and underserved groups ample access to and support for pursuing ocean-related graduate education.

Recommendation 23–1. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support expanded research and development efforts to encourage multidisciplinary studies of the evolution, ecology, chemistry, and molecular biology of marine species, discover potential marine bioproducts, and develop practical compounds, through both competitively awarded grants and support of federally designated centers.

Recommendation 23–2. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support expanded research efforts in marine microbiology and virology.

Recommendation 23–3. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support the development and implementation of improved methods for monitoring and identifying pathogens and chemical toxins in ocean waters and organisms.

Recommendation 26–7. The National Oceanic and Atmospheric Administration, National Science Foundation (NSF), the U.S. Navy, and National Aeronautics and Space Administration should require investigators who receive federal funding related to ocean research observatories, including the NSF Ocean Observatories Initiative, to develop plans for transferring new technologies to an operational mode in the Integrated Ocean Observing System.

F. U.S. Department of the Interior

Recommendation 20–7. The National Oceanic and Atmospheric Administration and the U.S. Department of the Interior should promote an expanded research, technology, and engineering program, coordinated through the National Ocean Council, to examine and mitigate the effects of human activities on marine mammals and endangered species.

Recommendation 24–2. The U.S. Department of the Interior should reverse recent budgetary trends and increase funding for the Minerals Management Service's Environmental Studies Program.

1. U.S. Geological Survey

Recommendation 12–4. The U.S. Army Corps of Engineers (USACE), National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, and U.S. Geological Survey should develop a strategy for improved assessment, monitoring, research, and technology development to enhance sediment management. Congress should modify its current authorization and funding processes to encourage USACE to monitor outcomes from past projects and study the cumulative, regional impacts of its activities within coastal watersheds and ecosystems.

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 15–3. 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.

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.

2. Minerals Management Service

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.

Recommendation 24–6. The Minerals Management Service should systematically identify the nation's offshore non-energy mineral resources and conduct the necessary cost-benefit, long-term security, and environmental studies to create a national program that ensures the best uses of those resources.

3. U.S. Fish and Wildlife Service

Recommendation 20–6. The National Marine Fisheries Service and the U.S. Fish and Wildlife Service should implement programmatic permitting for activities that affect marine mammals, wherever possible. More resource intensive case-by-case permitting should be reserved for unique activities or where circumstances indicate a greater likelihood of harm to marine mammals. The National Ocean Council should create an interagency team to recommend activities appropriate for programmatic permitting, those that are inappropriate, and those that are potentially appropriate pending additional scientific information. Enforcement efforts should also be strengthened and the adequacy of penalties reviewed.

G. U.S. Department of State

Recommendation 18–3. The U.S. Department of State and the 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.

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.

Recommendation 19–23. The U.S. Department of State, working with other appropriate entities, should encourage all countries to ratify the Fish Stocks Agreement and the United Nations Food and Agriculture Organization's Compliance Agreement. In particular, the United States should condition other nations' access to fishing resources within the U.S. exclusive economic zone on their ratification of these agreements. Other incentives should be developed by the United States and other signatory nations to encourage all nations to ratify and enforce these agreements.

Recommendation 19–24. The U.S. Department of State, working with the National Oceanic and Atmospheric Administration, should review and update regional and bilateral fishery agreements to which the United States is a party, to ensure full incorporation of the latest science and harmonize those agreements with the Fish Stocks Agreement.

Recommendation 21–3. The National Oceanic and Atmospheric Administration should develop national standards—and promote international standards—to ensure that coral reef resources that are collected, imported, or marketed are harvested in a sustainable manner. The U.S. Department of State should implement incentive programs to encourage international compliance with these standards.

Recommendation 29–4. The National Ocean Council's (NOC's) international committee (which is charged with supporting the development and implementation of ocean-related international policy) should assess emerging international ocean-related management challenges and make recommendations for either incorporating these activities under existing management regimes or developing appropriate new ones. The U.S. Department of State should work with the international community to implement these recommendations.

Recommendation 29–5. The U.S. Department of State should improve its integration of ocean-related scientific expertise in policy and program development and implementation.

Recommendation 29–7. The U.S. Department of State should offer strong support for U.S. scientists conducting research programs around the world. Existing international partnerships should be strengthened and new partnerships promoted to facilitate the conduct of international research.

H. National Aeronautics and Space Administration

Recommendation 8–3. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should strengthen their support of both formal and informal ocean-related education, including appropriate assessments and evaluation of these efforts.

Recommendation 8–7. Ocean.ED (the National Ocean Council's office of education), working with academic institutions and local school districts, should help establish stronger and more effective relationships between the research and education communities to expand professional development opportunities for teachers and teacher educators. The National Oceanic and Atmospheric Administration, National Science Foundation, the U.S. Navy, and National Aeronautics and Space Administration should support these efforts by providing secure and stable funding.

Recommendation 8–15. The National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and National Aeronautics and Space Administration should encourage and increase the participation of traditionally underrepresented and underserved groups in the ocean-related workforce. Ocean.ED should facilitate collaboration between these agencies and institutions of higher learning to ensure that the appropriate mix of programs and opportunities exists to provide underrepresented and underserved groups ample access to and support for pursuing ocean-related graduate education.

Recommendation 26–7. The National Oceanic and Atmospheric Administration, National Science Foundation (NSF), the U.S. Navy, and National Aeronautics and Space Administration should require investigators who receive federal funding related to ocean research observatories, including the NSF Ocean Observatories Initiative, to develop plans for transferring new technologies to an operational mode in the Integrated Ocean Observing System.

Recommendation 26–8. Congress should transfer the National Aeronautics and Space Administration's (NASA's) Earth environmental observing satellites, along with associated resources, to the National Oceanic and Atmospheric Administration (NOAA) to achieve continued operations. NOAA and NASA should work together to ensure the smooth transition of each Earth environmental observing satellite after its launch.

I. U.S. Department of Transportation

Recommendation 13–1. Congress should designate the U.S. Department of Transportation (DOT) as the lead federal agency for planning and oversight of the marine transportation system and DOT should submit regular reports on the condition and future needs of the system. The National Ocean Council should identify overlapping functions in other federal agencies and make recommendations concerning the advisability of transferring those functions to DOT.

Recommendation 13–3. The U.S. Department of Transportation should draft a new national freight transportation strategy to support continued growth of the nation's economy and international and domestic trade. This strategy should improve the links between the marine transportation system and other components of the transportation infrastructure, including highways, railways, and airports. Based on the new strategy, investments should be directed toward planning and implementation of intermodal projects of national significance.

Recommendation 13–4. The U.S. Department of Transportation should conduct a thorough analysis and assessment of the potential societal and economic benefits of increased short sea shipping.

Recommendation 13–5. The U.S. Department of Transportation (DOT), working with other appropriate entities, should establish a national data collection, research, and analysis program to provide a comprehensive picture of freight flows in the United States and to enhance the performance of the nation's intermodal transportation system. DOT should periodically assess and prioritize the nation's future needs for ports and intermodal transportation capacity to fulfill the needs of the nation's expected future growth in marine commerce.

Recommendation 13–6. In developing a national freight transportation strategy, the U.S. Department of Transportation should work closely with the U.S. Department of Homeland Security and the Federal Emergency Management Agency to incorporate port security and other emergency preparedness requirements. The strategy should focus on preventing threats to national security and port operations and on response and recovery practices that limit the impacts of such events, including an assessment of the availability of alternative port capacity.

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.

J. U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Environmental Health Sciences

Recommendation 23–1. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support expanded research and development efforts to encourage multidisciplinary studies of the evolution, ecology, chemistry, and molecular biology of marine species, discover potential marine bioproducts, and develop practical compounds, through both competitively awarded grants and support of federally designated centers.

Recommendation 23–2. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support expanded research efforts in marine microbiology and virology.

Recommendation 23–3. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support the development and implementation of improved methods for monitoring and identifying pathogens and chemical toxins in ocean waters and organisms.

K. U.S. Department of Agriculture

Recommendation 14–3. 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. 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.

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. 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.

L. U.S. Department of Labor

Recommendation 8–11. The National Oceanic and Atmospheric Administration and the U.S. Department of Labor should establish a national ocean workforce database and compile an annual report for the National Ocean Council on trends in ocean-related human resource development and needs. This effort should include an information clearinghouse to facilitate career decisions, provide access to career guidance, and enable employers, guidance counselors, and others to develop effective strategies to attract students to ocean-related careers. Ocean.ED, the National Ocean Council's office of education, should organize an ocean workforce summit every five years to address the alignment of ocean education with workforce needs.

M. Interagency groups

1. Aquatic Nuisance Species Task Force and the National Invasive Species Council

Recommendation 17–4. The Aquatic Nuisance Species Task Force and the National Invasive Species Council, 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.

2. National Dredging Team

Recommendation 12–3. The National Dredging Team and regional dredging teams should begin to implement more ecosystem-based approaches. The National Dredging Team should implement the recommendations of the 1994 report to the Secretary of Transportation, *The Dredging Process in the United States: An Action Plan for Improvement*, with a priority of developing and implementing a streamlined permitting process. Regional dredging teams, working with regional ocean councils, should establish sediment management programs that include watersheds, coastal areas, and the nation's shoreline.

3. U.S. Coral Reef Task Force

Recommendation 21–4. The U.S. Coral Reef Task Force should identify critical research and data needs related to coral reef ecosystems. These needs should guide agency research funding and be incorporated into the design and implementation of the Integrated Ocean Observing System.

IV. Recommendations to Regional Bodies

A. Regional Ocean Councils

Recommendation 5–1. State, territorial, tribal, and local governments and nongovernmental participants should use the broad, flexible process developed through the National Ocean Council to begin the establishment of regional ocean councils.

Recommendation 6–4. Regional ocean councils, or other appropriate regional entities, should actively solicit stakeholder participation and lead the design and implementation of marine protected areas. The design and implementation should be conducted pursuant to the goals, guidelines, and uniform process developed by the National Ocean Council.

Recommendation 11–2. The National Ocean Council should develop national goals for ocean and coastal habitat conservation and restoration efforts and should ensure coordination among all related federal activities. The regional ocean councils and regional ocean information programs should determine habitat conservation and restoration needs and set regional goals and priorities that are consistent with the national goals.

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 providing them with adequate technical, institutional, and financial support.

B. Regional Ocean Information Programs

Recommendation 5–3. Each regional ocean information program, with guidance from the National Ocean Council, should coordinate the development of a regional ecosystem assessment, to be updated periodically.

Recommendation 11–2. The National Ocean Council should develop national goals for ocean and coastal habitat conservation and restoration efforts and should ensure coordination among all related federal activities. The regional ocean councils and regional ocean information programs should determine habitat conservation and restoration needs and set regional goals and priorities that are consistent with the national goals.

C. Regional Fishery Management Councils

Recommendation 19–2. Scientific and Statistical Committees (SSCs) should be required to supply Regional Fishery Management Councils with the scientific information necessary to make fishery management decisions. Such information could include reports on stock status and health, socioeconomic impacts of management measures, sustainability of fishing practices, and habitat status. In particular, the SSCs should determine allowable biological catch based on the best scientific information available to them.

Recommendation 19–3. Each Regional Fishery Management Council should be required to set harvest limits at or below the allowable biological catch determined by its Scientific and Statistical Committee. The councils should begin immediately to follow this practice, which need to be codified at the next opportunity in amendments to the Magnuson–Stevens Fishery Conservation and Management Act.

Recommendation 19–5. Each Regional Fishery Management Council should set a deadline for its Scientific and Statistical Committee (SSC) to determine allowable biological catch. If the SSC does not meet that deadline, the National Marine Fisheries Service Regional Science Director should set the allowable biological catch for that fishery.

Recommendation 19–6. Once allowable biological catch is determined, whether by the Scientific and Statistical Committee or the National Marine Fisheries Service (NMFS) Regional Science Director, the Regional Fishery Management Council should propose a fishery management plan in time for adequate review and approval by NMFS. If the plan is not presented in a timely fashion, all fishing on that stock should be suspended until NMFS can review the adequacy of the management plan.

Recommendation 19–7. The Regional Fishery Management Councils and their Scientific and Statistical Committees should develop an annual, prioritized list of management information needs and provide it to the National Marine Fisheries Service (NMFS). NMFS should incorporate these needs to the maximum extent possible in designing its research, analysis, and data collection programs.

Recommendation 19–22. The National Marine Fisheries Service (NMFS) and Regional Fishery Management Councils should develop regional bycatch reduction plans that address broad ecosystem impacts of bycatch. Implementation of these plans will require NMFS to expand current efforts to collect data on bycatch, not only of commercially important species, but on all species captured by commercial and recreational fishermen. The selective use of observers should remain an important component of these efforts.

D. Regional Dredging Teams

Recommendation 12–3. The National Dredging Team and regional dredging teams should begin to implement more ecosystem-based approaches. The National Dredging Team should implement the recommendations of the 1994 report to the Secretary of Transportation, *The Dredging Process in the United States: An Action Plan for Improvement*, with a priority of developing and implementing a streamlined permitting process. Regional dredging teams, working with regional ocean councils, should establish sediment management programs that include watersheds, coastal areas, and the nation's shoreline.

IV. Recommendations related to International Affairs

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 by creating a code that outlines flag state responsibilities and obligations and instituting a voluntary audit regime.

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Recommendation 16–10. The United States should ratify Annex VI of the International Convention on the Prevention of Pollution from Ships 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.

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.

Recommendation 18–3. The U.S. Department of State and the 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.

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.

Recommendation 19–23. The U.S. Department of State, working with other appropriate entities, should encourage all countries to ratify the Fish Stocks Agreement and the United Nations Food and Agriculture Organization's Compliance Agreement. In particular, the United States should condition other nations' access to fishing resources within the U.S. exclusive economic zone on their ratification of these agreements. Other incentives should be developed by the United States and other signatory nations to encourage all nations to ratify and enforce these agreements.

Recommendation 19–24. The U.S. Department of State, working with the National Oceanic and Atmospheric Administration, should review and update regional and bilateral fishery agreements to which the United States is a party, to ensure full incorporation of the latest science and harmonize those agreements with the Fish Stocks Agreement.

Recommendation 19–26. The National Ocean Council's (NOC's) international committee, which is charged with supporting the development and implementation of ocean-related international policy, should initiate a process to determine the most effective methods of encouraging other nations to implement the United Nations Food and Agriculture Organization's Code of Conduct for Responsible Fisheries and other Plans of Action, and provide its findings to the U.S. Department of State and the NOC.

Recommendation 21–3. The National Oceanic and Atmospheric Administration should develop national standards—and promote international standards—to ensure that coral reef resources that are collected, imported, or marketed are harvested in a sustainable manner. The U.S. Department of State should implement incentive programs to encourage international compliance with these standards.

Recommendation 22–4. The United States should work with the United Nations Food and Agriculture Organization to encourage and facilitate worldwide adherence to the aquaculture provisions of the Code of Conduct for Responsible Fisheries.

Recommendation 26–11. The National Ocean Council (NOC) should promote international coordination and capacity building in the field of global ocean observations. The NOC should lead the U.S. implementation of the 2003 Declaration on Earth Observing, advocate full, open, and meaningful data access policies, and contribute technological expertise to ensure access by all nations.

Recommendation 29–1. The United States should accede to the United Nations Convention on the Law of the Sea.

Recommendation 29–2. The National Ocean Council should coordinate an expedited review and analysis of the ocean-related components of the United Nations Convention on Biological Diversity and recommend to the U.S. Department of State whether, from an ocean perspective, ratification of this treaty would be beneficial to U.S. interests.

Recommendation 29–3. The National Ocean Council (NOC) should establish and oversee an interagency committee to support the development and implementation of ocean-related international policy. This committee should be chaired by the U.S. Department of State, make recommendations to the Assistant to the President and the Secretary of State on international ocean policy, and provide technical assistance to the NOC on international ocean issues.

Recommendation 29–4. The National Ocean Council's international committee should assess emerging international ocean-related management challenges and make recommendations for either incorporating these activities under existing management regimes or developing appropriate new ones. The U.S. Department of State should work with the international community to implement these recommendations.

Recommendation 29–5. The U.S. Department of State should improve its integration of ocean-related scientific expertise in policy and program development and implementation.

Recommendation 29–6. The United States should continue to support and actively participate in major international ocean science organizations and programs.

Recommendation 29–7. The U.S. Department of State should offer strong support for U.S. scientists conducting research programs around the world. Existing international partnerships should be strengthened and new partnerships promoted to facilitate the conduct of international research.

U.S. Commission on Ocean Policy

Part X
Appendices

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Charlie S. Colgan

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Guide to Ocean-related Laws, Programs, Councils, Commissions, International Treaties, and Intergovernmental Bodies
(To be completed for the Final Report; not yet available)

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Proposed Structure for Coordination of Federal Ocean Activities

S.2327 PL 106-256

One Hundred Sixth Congress
Of the
United States of America
AT THE SECOND SESSION

AN ACT

To establish a Commission on Ocean Policy, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Section 1. Short Title

This Act may be cited as the "Oceans Act of 2000."

Section 2. Purpose and Objectives

The purpose of this Act is to establish a commission to make recommendations for coordinated and comprehensive national ocean policy that will promote—

(1) the protection of life and property against natural and manmade hazards;

(2) responsible stewardship, including use, of fishery resources and other ocean and coastal resources;

(3) the protection of the marine environment and prevention of marine pollution;

(4) the enhancement of marine-related commerce and transportation, the resolution of conflicts among users of the marine environment, and the engagement of the private sector in innovative approaches for sustainable use of living marine resources and responsible use of nonliving marine resources;

(5) the expansion of human knowledge of the marine environment including the role of the oceans in climate and global environmental change and the advancement of education and training in fields related to ocean and coastal activities;

(6) the continued investment in and development and improvement of the capabilities, performance, use, and efficiency of technologies for use in ocean and coastal activities, including investments and technologies designed to promote national energy and food security;

(7) close cooperation among all government agencies and departments and the private sector to ensure—

(A) coherent and consistent regulation and management of ocean and coastal activities;

(B) availability and appropriate allocation of Federal funding, personnel, facilities, and equipment for such activities;

(C) cost-effective and efficient operation of Federal departments, agencies, and programs involved in ocean and coastal activities; and

(D) enhancement of partnerships with State and local governments with respect to ocean and coastal activities, including the management of ocean and coastal resources and identification of appropriate opportunities for policy-making and decision-making at the State and local level; and

(8) the preservation of the role of the United States as a leader in ocean and coastal activities, and, when it is in the national interest, the cooperation by the United States with other nations and international organizations in ocean and coastal activities.

Section 3. Commission on Ocean Policy

(a) ESTABLISHMENT—There is hereby established the Commission on Ocean Policy. The Federal Advisory Committee Act (5 U.S.C. App.), except for chapters 3, 7, and 12, does not apply to the Commission.

(b) MEMBERSHIP—

(1) APPOINTMENT—The Commission shall be composed of 16 members appointed by the President from among individuals described in paragraph (2) who are knowledgeable in ocean and coastal activities, including individuals representing State and local governments, ocean-related industries, academic and technical institutions, and public interest organizations involved with scientific, regulatory, economic, and environmental ocean and coastal activities. The membership of the Commission shall be balanced by area of expertise and balanced geographically to the extent consistent with maintaining the highest level of expertise on the Commission.

(2) NOMINATIONS—The President shall appoint the members of the Commission, within 90 days after the effective date of this Act, including individuals nominated as follows:

(A) 4 members shall be appointed from a list of 8 individuals who shall be nominated by the Majority Leader of the Senate in consultation with the Chairman of the Senate Committee on Commerce, Science, and Transportation.

(B) 4 members shall be appointed from a list of 8 individuals who shall be nominated by the Speaker of the House of Representatives in consultation with the Chairmen of the House Committees on Resources, Transportation and Infrastructure, and Science.

(C) 2 members shall be appointed from a list of 4 individuals who shall be nominated by the Minority Leader of the Senate in consultation with the Ranking Member of the Senate Committee on Commerce, Science, and Transportation.

(D) 2 members shall be appointed from a list of 4 individuals who shall be nominated by the Minority Leader of the House in consultation with the Ranking Members of the House Committees on Resources, Transportation and Infrastructure, and Science.

(3) CHAIRMAN—The Commission shall select a Chairman from among its members. The Chairman of the Commission shall be responsible for—

(A) the assignment of duties and responsibilities among staff personnel and their continuing supervision; and

(B) the use and expenditure of funds available to the Commission.

(4) VACANCIES—Any vacancy on the Commission shall be filled in the same manner as the original incumbent was appointed.

(c) RESOURCES—In carrying out its functions under this chapter, the Commission—

(1) is authorized to secure directly from any Federal agency or department any information it deems necessary to carry out its functions under this Act, and each such agency or department is authorized to cooperate with the Commission and, to the extent permitted by law, to furnish such information (other than information described in chapter 552(b)(1)(A) of title 5, United States Code) to the Commission, upon the request of the Commission;

(2) may enter into contracts, subject to the availability of appropriations for contracting, and employ such staff experts and consultants as may be necessary to carry out the duties of the Commission, as provided by chapter 3109 of title 5, United States Code; and

(3) in consultation with the Ocean Studies Board of the National Research Council of the National Academy of Sciences, shall establish a multidisciplinary science advisory panel of experts in the sciences of living and nonliving marine resources to assist the Commission in preparing its report, including ensuring that the scientific information considered by the Commission is based on the best scientific information available.

(d) STAFFING—The Chairman of the Commission may, without regard to the civil service laws and regulations, appoint and terminate an Executive Director and such other additional personnel as may be necessary for the Commission to perform its duties. The Executive Director shall be compensated at a rate not to exceed the rate payable for Level V of the Executive Schedule under chapter 5136 of title 5, United

States Code. The employment and termination of an Executive Director shall be subject to confirmation by a majority of the members of the Commission.

(e) MEETINGS—

(1) ADMINISTRATION—All meetings of the Commission shall be open to the public, except that a meeting or any portion of it may be closed to the public if it concerns matters or information described in chapter 552b(c) of title 5, United States Code. Interested persons shall be permitted to appear at open meetings and present oral or written statements on the subject matter of the meeting. The Commission may administer oaths or affirmations to any person appearing before it.

(2) NOTICE; MINUTES; PUBLIC AVAILABILITY OF DOCUMENTS— [1]

(A) All open meetings of the Commission shall be preceded by timely public notice in the *Federal Register* of the time, place, and subject of the meeting.

(B) Minutes of each meeting shall be kept and shall contain a record of the people present, a description of the discussion that occurred, and copies of all statements filed. Subject to chapter 552 of title 5, United States Code, the minutes and records of all meetings and other documents that were made available to or prepared for the Commission shall be available for public inspection and copying at a single location in the offices of the Commission.

(3) INITIAL MEETING—The Commission shall hold its first meeting within 30 days after all 16 members have been appointed.

(4) REQUIRED PUBLIC MEETINGS—The Commission shall hold at least one public meeting in Alaska and each of the following regions of the United States:

(A) The Northeast (including the Great Lakes).

(B) The Southeast (including the Caribbean).

(C) The Southwest (including Hawaii and the Pacific Territories).

(D) The Northwest.

(E) The Gulf of Mexico.

(f) REPORT—

(1) IN GENERAL—By June 20, 2003,[2] the Commission shall submit to Congress and the President a final report of its findings and recommendations regarding United States ocean policy.

(2) REQUIRED MATTER—The final report of the Commission shall include the following assessment, reviews, and recommendations:

(A) An assessment of existing and planned facilities associated with ocean and coastal activities including human resources, vessels, computers, satellites, and other appropriate platforms and technologies.

(B) A review of existing and planned ocean and coastal activities of Federal entities, recommendations for changes in such activities necessary to improve efficiency and effectiveness and to reduce duplication of Federal efforts.

(C) A review of the cumulative effect of Federal laws and regulations on United States ocean and coastal activities and resources and an examination of those laws and regulations for inconsistencies and contradictions that might adversely affect those ocean and coastal activities and resources, and recommendations for resolving such inconsistencies to the extent practicable. Such review shall also consider conflicts with State ocean and coastal management regimes.

(D) A review of the known and anticipated supply of, and demand for, ocean and coastal resources of the United States.

(E) A review of and recommendations concerning the relationship between Federal, State, and local governments and the private sector in planning and carrying out ocean and coastal activities.

(F) A review of opportunities for the development of or investment in new products, technologies, or markets related to ocean and coastal activities.

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[1] HR 4883 – Hydrographic Services Improvement Act

[2] PL 107-206 (section 206)

(G) A review of previous and ongoing State and Federal efforts to enhance the effectiveness and integration of ocean and coastal activities.

(H) Recommendations for any modifications to United States laws, regulations, and the administrative structure of Executive agencies, necessary to improve the understanding, management, conservation, and use of, and access to, ocean and coastal resources.

(I) A review of the effectiveness and adequacy of existing Federal interagency ocean policy coordination mechanisms, and recommendations for changing or improving the effectiveness of such mechanisms necessary to respond to or implement the recommendations of the Commission.

(3) CONSIDERATION OF FACTORS—In making its assessment and reviews and developing its recommendations, the Commission shall give equal consideration to environmental, technical feasibility, economic, and scientific factors.

(4) LIMITATIONS—The recommendations of the Commission shall not be specific to the lands and waters within a single State.

(g) PUBLIC AND COASTAL STATE REVIEW—

(1) NOTICE—Before submitting the final report to the Congress, the Commission shall—

(A) publish in the *Federal Register* a notice that a draft report is available for public review; and

(B) provide a copy of the draft report to the Governor of each coastal State, the Committees on Resources, Transportation and Infrastructure, and Science of the House of Representatives, and the Committee on Commerce, Science, and Transportation of the Senate.

(2) INCLUSION OF GOVERNORS' COMMENTS—The Commission shall include in the final report comments received from the Governor of a coastal State regarding recommendations in the draft report.

(h) ADMINISTRATIVE PROCEDURE FOR REPORT AND REVIEW—
Chapter 5 and chapter 7 of title 5, United States Code, do not apply to the preparation, review, or submission of the report required by subchapter (e) or the review of that report under subchapter (f).

(i) TERMINATION—The Commission shall cease to exist 90[3] days after the date on which it submits its final report.

(j) AUTHORIZATION OF APPROPRIATIONS—There are authorized to be appropriated to carry out this chapter a total of $8,500,000[4] for the 3-fiscal-year period beginning with fiscal year 2001, such sums to remain available until expended.

Section 4. National Ocean Policy

(a) NATIONAL OCEAN POLICY—Within 90[5] days after receiving and considering the report and recommendations of the Commission under chapter 3, the President shall submit to Congress a statement
of proposals to implement or respond to the Commission's recommendations for a coordinated, comprehensive, and long-range national policy for the responsible use and stewardship of ocean and coastal resources for the benefit of the United States. Nothing in this Act authorizes the President to take any administrative or regulatory action regarding ocean or coastal policy, or to implement a reorganization plan, not otherwise authorized by law in effect at the time of such action.

(b) COOPERATION AND CONSULTATION—In the process of developing proposals for submission under subchapter (a), the President shall consult with State and local governments and non-Federal organizations and individuals involved in ocean and coastal activities.

[3] HR 4883 – Hydrographic Services Improvement Act
[4] HR 4883 – Hydrographic Services Improvement Act
[5] HR 4883 – Hydrographic Services Improvement Act

Section 5. Biennial Report

Beginning in September, 2001, the President shall transmit to the Congress biennially a report that includes a detailed listing of all existing Federal programs related to ocean and coastal activities, including a description of each program, the current funding for the program, linkages to other Federal programs, and a projection of the funding level for the program for each of the next 5 fiscal years beginning after the report is submitted.

Section 6. Definitions

In this Act:

(1) MARINE ENVIRONMENT—The term "marine environment" includes—

(A) the oceans, including coastal and offshore waters;

(B) the continental shelf; and

(C) the Great Lakes.

(2) OCEAN AND COASTAL RESOURCE—The term "ocean and coastal resource" means any living or non-living natural, historic, or cultural resource found in the marine environment.

(3) COMMISSION—The term "Commission" means the Commission on Ocean Policy established by chapter 3.

Section 7. Effective Date

This Act shall become effective on January 20, 2001. Passed in the Senate June 6, 2000.

Appendix B -- Acronyms Appearing in the Preliminary Report

AAAS	American Association for the Advancement of Science
AUV	Autonomous Underwater Vehicle
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
CALFED	California Bay-Delta Program
CBD	Convention on Biological Diversity
CDC	Centers for Disease Control and Prevention
CDIAC	Carbon Dioxide Information Analysis Center
CEIP	Coastal Energy Impact Plan
CIAP	Coastal Impact Assistance Program
CIESIN	Center for International Earth Science Information Network
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CoML	Census of Marine Life
COSAT	Committee on Ocean Science, Applications, and Technology
COSEE	Centers for Ocean Science Education Excellence
CZARA	Coastal Zone Act Reauthorization Amendments
CZMA	Coastal Zone Management Act
DAACs	Distributed Active Archive Centers
DOI	Department of the Interior
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIC	Environment as an Integrating Context
EIS	Environmental Impact Statement
EOP	Executive Office of the President
EPA	Environmental Protection Agency
EROS	Earth Resources Observation Systems
EROSDC	Earth Resources Observation Systems Data Centers
ESA	Endangered Species Act
ESP	Environmental Studies Program
FCMA	Fishery Conservation and Management Act
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
GAO	General Accounting Office
GDP	Gross Domestic Product
JEA	Joint Enforcement Agreement
JSA	Joint Subcommittee on Aquaculture
GPA	Global Program of Action for the Protection of the Marine Environment from Land-Based Sources
GSFC	Goddard Space Flight Center
HAB	Harmful Algal Bloom
ICRI	International Coral Reef Initiative
IDOE	International Decade of Ocean Exploration
IFQs	Individual Fishing Quotas
IMO	International Maritime Organization
IOC	U.N. Intergovernmental Oceanographic Commission
IOOS	Integrated Ocean Observing System
ITQs	Individual Transferable Quotas
LaRC	Langley Research Center
LOS Convention	United Nations Convention on the Law of the Sea
MARPOL	International Convention for the Prevention of Pollution from Ships
MERP	Marine Entanglement Research Program
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MPRSA	Marine Protection, Research, and Sanctuaries Act
MREFC	Major Research Equipment and Facilities Construction

M-S Act	Magnuson-Stevens Fishery Conservation and Management Act
MSDs	Marine Sanitation Devices
MSIs	Minority Serving Institutions
NACOA	National Advisory Committee on Oceans and Atmosphere
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Center
NDSF	National Deep Submergence Facility
NEIC	National Earthquake Information Center
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NERRS	National Estuarine Research Reserve System
NFIP	National Flood Insurance Program
NGDC	National Geophysical Data Center
NIEHS	National Institute of Environmental Health Sciences
NISA	National Invasive Species Act
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOC	National Ocean Council
NODC	National Oceanographic Data Center
NOPA	National Oceanographic Partnership Act
NOPP	National Oceanographic Partnership Program
NORLC	National Ocean Research Leadership Council
NPS	National Park Service
NRC	National Research Council
NSES	National Science Education Standards
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
NSSDC	National Space Science Data Center
NWS	National Weather Service
OBIS	Ocean Biogeographic Information System
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OMB	Office of Management and Budget
ONR	Office of Naval Research
OPA '90	Oil Pollution Act of 1990
ORNL	Oak Ridge National Laboratory
OSTP	Office of Science and Technology Policy
OTEC	Ocean Thermal Energy Conversion
PCBs	Polychlorinated biphenyls
PODAAC	Physical Oceanography Distributed Active Archive Centers
ROV	Remotely Operated Vehicle
RSM	Regional Sediment Management
SAR	Synthetic Aperture Radar
SEDAC	Socioeconomic Data and Applications Center
SSC	Scientific and Statistical Committee
TMDL	Total Maximum Daily Load
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Program
UNOLS	University National Oceanographic Laboratory System
USACE	U.S. Army Corps of Engineers
USAID	U.S. Agency for International Development
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VMS	Vessel Monitoring Service
WTO	World Trade Organization

LIVING NEAR… AND MAKING A LIVING FROM… THE NATION'S COASTS AND OCEANS

Prepared for the
United States Commission on Ocean Policy

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October 2003

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Executive Summary

More than thirty years ago, the Stratton Commission identified growing population pressures on the coasts as a major reason for increased federal government attention to managing the resources of the coasts, oceans and Great Lakes. Socio-economic changes have continued to affect the nation's oceans and coasts over the three decades since the Stratton Commission report, but in much more complex ways than simple population growth alone. More people live on and near the coasts, but it is population growth away from the coast that may be the greatest cause for concern. Population growth near the coast is being outstripped by even faster employment growth, and in industries which appear clean but whose cumulative effects on the environment are significant.

The ocean has always been an important part of the economic life of the nation, but this too is undergoing dramatic change. Economic activity associated with the ocean contributed more than $200 billion to the U.S. economy in 2000, but employment in such traditional marine industries as fishing and marine transportation is declining, while employment in tourism and recreation industries is exploding. Some industries, such as ocean minerals and maritime transportation are producing more with fewer employees, while others such as commercial fishing are declining in both output and employment.

Changes in the socio-economic environment affecting the nation's oceans and coasts are essential to any consideration of public policy. This is so for three reasons:

1. Changes in how people use the ocean and coasts have profound effects on the natural resources.
2. The changes in the resources feed back to changes in the demographic and economic uses altering our uses and perceptions of the coasts and oceans.
3. To manage a resource you must manage the people who use it. Whatever form it takes, policy affects people's behavior, and so how people interact with the environment is the key to the future of the oceans.

This report explores key changes in the socio-economic environment of the nation's oceans and coasts using the latest data from the Census and a special study of the coastal and ocean economies of the United States prepared for the Commission by the National Ocean Economics Project, an independent investigation of the national ocean economy funded by NOAA and EPA. Major conclusions from this analysis include:

1. The term "coast" requires precise definition for measurement. The socio-economic definition of the coast includes at least three tiers, ranging from the near shore, the areas covered by state coastal management programs, and the counties that include coastal watersheds.

2. Population growth since 1970 in coastal watershed counties exceeded 37.5 million people, but this reflected the same rate of growth as the nation as a whole. This means that the coasts are not the destination of disproportionately large growth, but the sheer increase in the population on the same relative small land base still produces major effects.

3. Population and housing growth is shifting inland away from the shoreline. Expensive real estate and past growth have resulted in slow growth near the oceans and Great Lakes, while upland areas have absorbed more of the growth over the past decade and will likely continue to do so.

4. The largest population growth has been along the Atlantic and Pacific coasts, but the fastest population growth by far has been along the coasts of the Gulf of Mexico. The Great Lakes have seen a slight decline in population, but housing growth has continued.

5. Rural areas of the coast have seen much faster growth than urban areas. The farther from cities, the faster the population growth has been. Both year round and seasonal population and housing growth in rural counties have been substantial.

6. The coastal economy is different from the ocean economy. The coastal economy is the sum of all economic activity taking place in the coastal area, while the ocean economy is the economic activity using the ocean as an input.

7. While coastal *populations* have been growing consistent with national trends, the coastal *economy* has been growing faster. And while population has been growing more slowly near the shore than in the nation, the *economy* has been growing much faster. The region nearest the shore also accounts for 11% of the U.S. economy, while comprising just 4% of its land area.

8. The ocean economy, comprised of the living resources, minerals, construction, transportation, and tourism & recreation sectors, also grew slightly faster than the national economy over the last decade. But tourism and recreation was the only ocean economy sector to show employment growth; all other sectors saw declines in employment in the last decade.

9. The ocean economy is overwhelmingly urban in location, with over 90% of the jobs in the ocean economy located in metro areas. But the ocean economy is proportionately twice as important in rural counties as a proportion of the economy.

Data supporting these conclusions are presented in this paper. For a detailed discussion of the methods used to derive the data used see (Colgan 2003).

In addition to the importance of the ocean and coasts to the national economy, recent research on the value of ocean and coastal resources has also begun to reveal the huge economic values that lie beyond what is reflected in measures such as employment and industrial output While no single number can encapsulate these values, these studies show additional evidence of the importance of the oceans and coasts for recreation, and has begun to make clear how important resources such as coral reefs and estuaries are to the economic life of the nation.

There are numerous implications of these trends for the management of the nation's coastal and ocean resources. Policy responses to the impacts of "sprawl" development must address different types of sprawl in different parts of the coast. Population growth trends indicate continued large increases in population density on the coast, but at different rates in different parts of the coast. Population and housing impacts in recent years are focused more on the upland areas of the coastal watersheds and less on the near shore areas. But exactly the opposite trend is occurring in commercial and overall employment growth, where the near shore areas growing more rapidly- and more intensely- than upland areas.

Attempts to improve the "land-side" aspects of coastal and resource management must therefore focus on a number of issues about which there has been relatively little discussion. Economic growth in the near shore area has tended to focus in the trade and service industries (like the rest of the economy), which uses more land per unit of output than other types of activity. Managing the impacts of such commercial growth is very important, particularly because a high proportion is directly related to tourism and recreation uses of the coast. The coasts, particularly the near shore areas, are also the location for very high short-term population growth- from commuters, seasonal vacationers, day-use recreationists, and others. The population pressures on the near shore area are many times those implied by the year-round populations measured by the Census and reported here.

The changes in the ocean economy will also require thinking about how we use the ocean in some new ways. Clearly rebuilding the fish stocks to sustainable levels is a vital part of improving both the natural and economic health of the oceans. Other economic uses of the ocean, such as offshore oil and gas and maritime transportation, will play important even growing roles in the national economy, but will likely do so with stable or even shrinking employment levels. And tourism and recreation, which has come to dominate much of the ocean economy, will only grow further in economic importance- and impacts on coastal and ocean resources, as society gains in wealth and leisure and moves towards a huge increase in retirees over the next two decades.

The insights offered by the data analyzed in this report are useful but still incomplete. Our understanding of the economic values of coasts and oceans economies is weak. In contrast to areas like agriculture where the federal government spends over $100 million a year on economic research, the federal government makes no sustained or significant effort to monitor and expand our understanding of the economic values associated with the coasts and oceans. A sustained effort of $8-10 million a year is needed to catalyze a cooperative effort among NOAA, the federal statistical agencies, related federal agencies (NSF and EPA), and the university and private research community to develop data and analysis to improve our understanding in this area.

1. Introduction

A constant theme in discussions of the nation's coasts and oceans, including the Great Lakes, is what the Stratton Commission called the "intensifying use of coastal area"(Commission on Marine Science Engineering and Resources 1969). One particular concern has been a large and steadily increasing population. A frequently cited figure is that the coast contains over half of the population of the U.S., but just over 11% of the area. ((Rappaport and Sachs 2001);(Bookman, Culliton et al. 1998)) Another concern has been the level of economic activity taking place in coastal areas and its effects on resources. There is no doubt that the pressure of population and economic activity on the limited resources of the coasts and oceans is large and growing. The U.S. Ocean Policy Commission received substantial input to this effect. But the socioeconomic forces at work are at once more subtle and dramatic than are usually cited.

Reshaping America's policies towards the oceans in the future must rest on an understanding of those forces. This report examines major trends over the past one to three decades in the socio-economic forces affecting America's coasts and oceans. The report uses primary Census and economic data from federal and state sources to explore how population, housing, employment and earnings, and production in the coastal regions are changing. The data in this report includes standard Census data as well as special analyses of economic data prepared for the Commission by the National Ocean Economics Project, an independent research effort funded by NOAA and EPA. This data on the coastal and ocean economy has not been previously available.

The report begins by examining the term "coast" to provide some definitional clarity to a term that has been used with so many different meanings that it is almost impossible to compare one study to another. Next, it explores population and housing trends, both over the thirty years since the Stratton Commission report as well over the most recent decade. It then explores the coastal and ocean economy, making a distinction between the myriad of economic activities that take place in coastal regions and those that are directly tied to the oceans and Great Lakes. This analysis focuses on the measurement of economic activity involving market transactions and measured by widely-used statistical series. Beyond these measures, researchers are uncovering important evidence that the size of the economic values associated with the coasts and oceans are much larger than conventional measures capture.

The report then examines the implications of these trends for coastal and ocean resource management policy, and concludes with a discussion of the need for future commitments to maintain and improve our understanding of the socio-economic environment of the oceans.

2: Defining the Coast

What is meant by the "coast"? The figures cited above that more than 50% of the U.S. population is "on the coast" includes the population in all counties[1] within 50 miles (80 km) of the shoreline. The 50 mile boundary reflects both the resident population of the coast and those who live "within a day's drive" and thus are likely to be frequent visitors to the shore. This definition of the coast encompasses a substantial amount of inland geography that would not be immediately recognized as coastal by either residents or visitors. To get a better picture of the population trends affecting the coast requires three different perspectives on the idea of "coast":

- *Near shore* The population in the region closest to the shore area and thus the population with the greatest effect on the fragile shoreline. In this report, the near shore population is measured by the population living in zip codes adjacent to the shore as defined by the Census Zip Code Tabulation Areas. (Bureau of the Census 2003) Employment, wages, and output of the near shore area is defined by the zip code of reporting establishments in the Bureau of Labor Statistics employment data.

- *Coastal Zone Counties*. This is the population living in the counties which are included in whole or in part in the coastal zone as defined by the states for purposes of the Coastal Zone Management Act.[2] The coastal zone defined by the states varies significantly from state to state. In four states,[3] the coastal zone includes the entire state. In other states the coastal zone is defined by political jurisdictions such as towns and counties[4] and while still others define it by natural features. This wide variation makes the "coastal zone" a difficult basis for comparison, but as the Coastal Zone Management Program is one of the most significant accomplishments stemming from the Stratton Commission, it requires examination.

- *Coastal Watershed Counties* The boundaries of the near shore and coastal zone are largely determined for political and administrative purposes, and thus intersect natural regions only by chance or in those states that explicitly define their coastal zone to match natural boundaries. Another important perspective is to look at counties that include the watersheds of coastal areas, since the effects of population growth in upland areas sooner or later flow to the sea down coastal rivers and streams. Coastal watershed counties have been defined by NOAA as a means of more closely aligning political and natural boundaries. (National Oceanic and Atmospheric Administration 2001)

3. Trends in Population and Housing

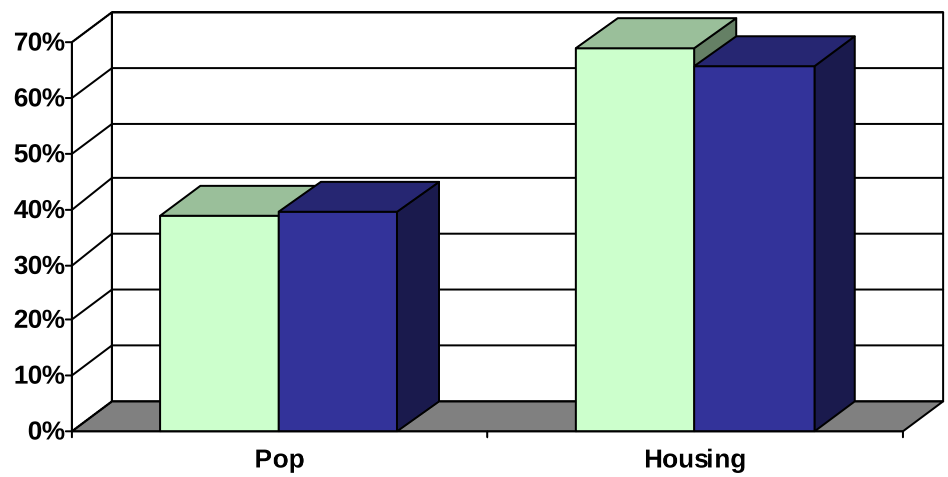
National Trends

Population growth pressures are probably the most frequently cited socioeconomic force affecting the coast. Analysis of Census data from 1970 to 2000 shows that population growth in coastal areas has indeed been substantial, but as the coast is more complicated than a single term can encompass, so have been the population and housing dynamics. Table 1 (all tables may be found on pages 29 and following) provides the data overview of the most important changes. These include:

- From 1970-2000, the population in coastal watershed counties increased by more than 37.5 million people, an amount equivalent to adding the total (year 2000) populations of California and Oregon to the United States.

- Coastal Zone counties grew by more than 28 million people, an amount larger than the 2000 populations of Texas and Virginia.

Figure C.1
Population and Housing Growth 1970-2000



Source: U.S. Census

- The population growth rates of coastal zone and coastal watershed counties have not been consistently more rapid than the nation as a whole. In fact, over the thirty year period, both tiers of coastal counties grew slightly more slowly than the nation. Both types of coastal counties did grow more rapidly than the nation during the 1980s, but not in the 1970s or 1990s. In the 1970s, population growth was rapid in inland areas associated with energy development. In the 1990s population growth was rapid in the inter-mountain west and southeast in the wake while the coastal regions endured the effects of a prolonged slump in growth.

- Over the last decade, population growth has been fastest away from the shoreline but also in the *counties* adjacent to the shore. When all three tiers are examined in the 1990s (data for the near shore area is available only for 1990 and 2000), the slowest growth was in the near shore tier, while the fastest growth was in the coastal zone counties. This inland shift of population results from the fact that much of the coastline is already developed and tends to be among the most expensive real estate. But rapid population growth has not yet shifted towards the farther reaches of the watersheds. Growth remains concentrated near, but not on, the shoreline.

The proportion of the total United States population in the coastal watershed and coastal zone counties has declined slightly over the past thirty years, but the proportion of population in these counties remains nearly twice their proportion of the land area of the country. (Table 2) The proportion of the population in the *near shore* coastal area in 2000 is more than three times the proportion of land area of the near shore.

This means the population density of the coastal regions is significantly higher than the nation as a whole. The national density of 79 persons per square mile of land area (in 2000) is exceeded substantially in the near shore area, where there were more than 230 persons per square mile.[5] While the population density increased by 22 people per square mile nationally from 1970 to 2000, it increased by 43 people per square mile in the coastal counties.

Regional Trends in Population Growth

Trends in population growth in coastal regions have not been consistent across the nation. Figure 2 summarizes the population change from 1970 to 2000 by region[6]. (See also Table 3)

- The Atlantic and Pacific regions show the largest population growth, but the Gulf of Mexico region shows by far the fastest population growth. The coastal zone counties along the Gulf almost *doubled* in population over the past thirty years. Much of this growth occurred in Florida.

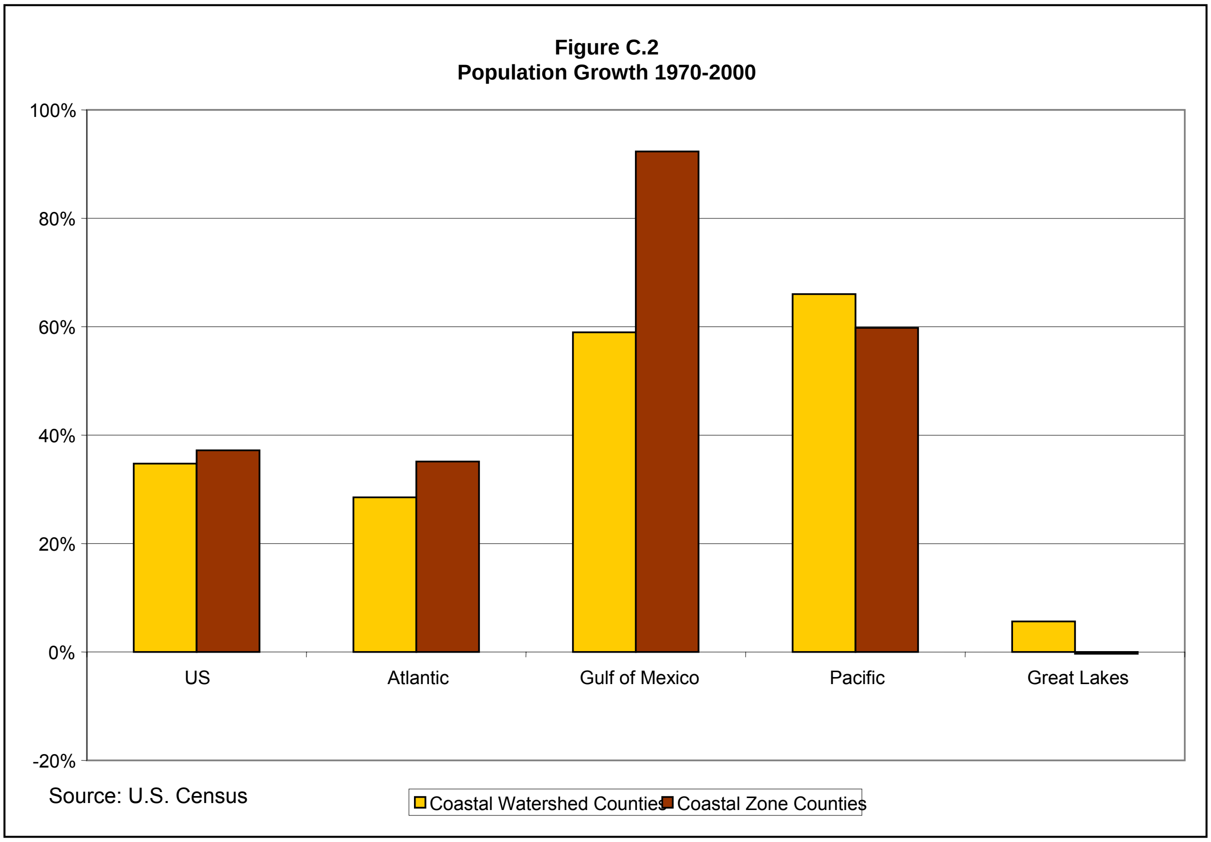
- The Great Lakes region saw a population decline in the coastal zone counties from 1970-2000, primarily due to trends in the 1970s. This was due in large part to population declines in cities such as Detroit and Cleveland.

- Population growth trends differed in each region across the three decades, but the 1990s saw the greatest absolute *amount* of growth in all regions.

- Growth accelerated across the decades in the Atlantic region and the Great Lakes, recovered from a population loss in the 1970s to a gain in the 1990s. Growth rates were faster in the 1980s in the Pacific. The Gulf of Mexico saw the fastest growth in coastal zone counties in all three decades.

- The fastest growth in the near shore region over the past decade was in the Gulf of Mexico, the slowest in the Great Lakes.

Trends in the large regions examined here illustrate some of the major variations in population growth across the country. Important additional variations exist within each of the regions between and within states. One of the most important of these variations is the different rates of growth in urban and rural areas (Table 4).[7]



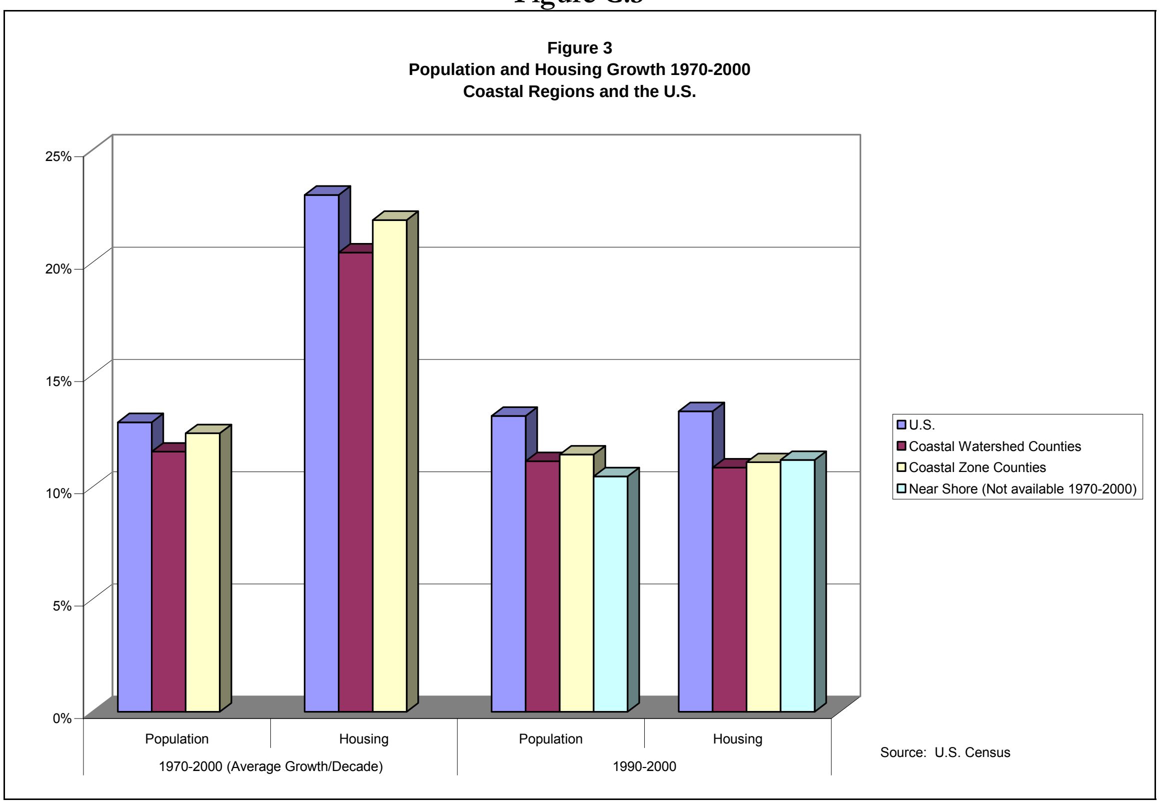
Over the past thirty years, the population growth rate in rural areas substantially exceeds that of urban areas. Rural coastal zone counties grew by more than 57% from 1970 to 2000, compared with 38% growth in urban coastal zone counties. Population growth has been most rapid in those urban region counties which are furthest from the central city and in those rural counties furthest from the city with at least one large community.[8]

Trends in Housing Growth

The potential for population growth's impact on coastal and ocean resources extends beyond the sheer number of people who reside in coastal areas. That potential is also driven by the growth in the number of housing units in a region, which is a principal source of demand for land that may otherwise be used for wildlife habitat, wetlands, etc. Much of the growth in America takes place in a pattern which has come to be called "sprawl", which involves extensive spreading out of housing and economic activity across the landscape. Coastal areas are very much characterized by sprawling patterns of growth. (Beach 2003)

Figure 3 shows the comparative growth rates of housing and population in coastal watershed and coastal zone counties from 1970-2000. Over the whole period, housing growth has substantially exceeded population growth, although the differences in rates diminished by the 1990s. The trends of faster housing growth than population growth is particularly strong in the Great Lakes region, which saw a slight decline (0.4%) in the population in Coastal Zone counties of over the three decades, but an increase in housing in the same counties of nearly 25%.

Figure C.3



Rural coastal zone counties also grew substantially faster in housing than urban coastal zone counties. From 1970-2000, the number of housing units in rural coastal counties more than doubled (a 107% growth rate), while housing grew 63% in urban counties over the same period. Smaller coastal zone counties in urban regions saw very fast housing growth rates. Coastal zone counties at the fringe of urban areas had the fastest rate of housing growth in any of the urban-rural county types, with an increase of over 150% from 1970-2000.

Two major factors drive these trends in housing relative to population growth. A certain amount of housing growth is required for population growth, but a major factor is the falling size of U.S. households. In 1970 the average household consisted of 3.14 persons; by 2000 this was reduced to 2.59 persons. (Bureau of the Census 2001) This change alone accounts for more than half of the growth in housing. Another factor that heavily influences rapid growth in coastal regions is the growth in seasonal housing, which tends to be concentrated in rural counties.

Summary of Population and Housing Trends

Population growth continues to place significantly increased pressure on coastal regions. Total population growth has not been disproportionately located in coastal counties, but the sheer magnitude of that growth on the limited land area of coastal regions creates a much heavier "footprint" than in other parts of the country. Population densities in coastal areas are two to three times as high as in the nation as a whole, reflecting both the attraction of the coast and the intensity of use.

The population of coastal regions is shifting inland, away from the shore and towards the upland areas of coastal watersheds. This trend is most noticeable in the counties closest to the shore. The fastest population growth is occurring in the counties bordering the Gulf of Mexico, particularly in Florida. The largest population growth has been occurring in the Pacific, particularly in California. Population growth has been occurring much more rapidly in rural coastal zone counties than urban coastal zone counties, and in those counties at the fringe of urban regions.

Housing growth exceeds population growth in the coastal areas, especially in the Great Lakes region and in rural coastal zone counties. This pattern of growth puts stresses on natural resources well in excess of that suggested by simple measurement of population growth. In 1969, the Stratton Commission noted that the pressures on the coastal zone were expanding seaward. While this is true, the expansion of population pressures inland and away from the urban areas may be the most important trend over the past thirty years. These trends will almost certainly continue well into the future, since they reflect both fundamental economic forces such as land value that affect where housing is affordable.

Restoring and enhancing the nation's coastal resources will require increased attention not only on the land forms, such as the Big Sur coast of California or the beaches of the Atlantic that form the coast of the popular imagination. It will require increased attention on the less populated rural parts of the coast where change is occurring most rapidly and on the upland areas of watersheds where the accumulation of subtle changes are magnified in the water rivers, streams, and lakes of the area as water flows to the sea.

4. The Coastal and Ocean Economy of the United States

It is no exaggeration to say that the American economy began on the coasts and oceans. Of course all the early European settlements were along the coast, and from these sprouted not only many of America's great cites but America itself. But even before the first permanent settlements in Virginia and Massachusetts, Europeans were venturing across the Atlantic to fish. (Innis 1940) Native Americans were using the shore as their summer home centuries before the mansions of Newport were built. (Larrabee, Fowler et al. 1998) The nation grew around the ports, and trade they made possible. So the connection of the economy to the sea has been, and remains a vital one in the livelihood of the nation.

Seeing the importance of the ocean in America's past is not difficult. Understanding the role of the ocean and coasts in today's huge and complex economy is more difficult. There are many isolated facts that have been collected about the nation's ocean and coastal economy which attest to the continued importance of the ocean to the economy, but little in the way of systematic measurement has been available.[9] A major effort to develop a systematic and consistent measurement of economic activity associated with the coasts and ocean, the National Ocean Economics Project, has provided new insights into how the nation's economy depends on its coasts and oceans- and how that dependence is undergoing dramatic changes.[10]

The terms "ocean" and "coastal" economy are often applied in a way that implies they are synonymous, but they are not.

> The *ocean economy* is that portion of the economy which relies on the ocean as an input to the production process or which, by virtue of geographic location, takes place on or under the ocean.
>
> The *coastal economy* is that portion of economic activity which takes place on or near the coast.

The reason for this distinction stems from the fact that the "ocean" and "coast" are two different resources. The "ocean" provides a variety of products and services such as food, recreation, and transportation. The "coast", on the other hand is a region which provides access to the services of the ocean as well as being a specific economy within larger regions. The coast contains both ocean and many non-ocean related economic activities, and is much larger than the ocean economy. The coast economy describes the category of economic activity that creates much of the impact on coastal resources, while the ocean economy is the direct connection between the sea, the Great Lakes, and the nation's overall economic growth.

The ocean economy can be divided into the following broad sectors and industries:[1]

- *Living resources* (fisheries harvesting and processing, aquaculture, seaweed harvesting)
- *Marine construction* (construction of piers and wharves, dredging, beach reconstruction)
- *Ship and boat building*
- *Marine transportation* (transportation of both freight and passengers)
- *Minerals* (oil and gas, sand and gravel, miscellaneous other mineral resources)
- *Tourism and recreation* (restaurants, lodging, recreation services, marinas, boat dealers)
- *Scientific Research* (oceanographic, biological, ecological)
- *Government* (Federal, state, and local agencies that use or manage ocean resources).

Some of these industries are related to the ocean by what they do, such as marine transportation of goods and people. Other industries are ocean-related because of where they are. Tourism and recreation industries such as hotels or recreation services are ocean related when located in the near shore area, defined by being in a shore-adjacent zip code.

The data used in this analysis are based on the ES-202 data employment and wage data series collected by the U.S. Department of Labor Bureau of Labor Statistics. It is based on establishment-level monthly reports of employment and wages. Estimates of gross output are based on the gross state product estimates from the U.S. Department of Commerce Bureau of Economic Analysis. For more information see (Colgan 2003).

Table 5 shows establishments, employment, wages, and output (share of gross state product) for the total economy of the coastal regions (the near shore zip-code defined regions plus the coastal zone and coastal watershed counties) in 1990 and 2000.[11]

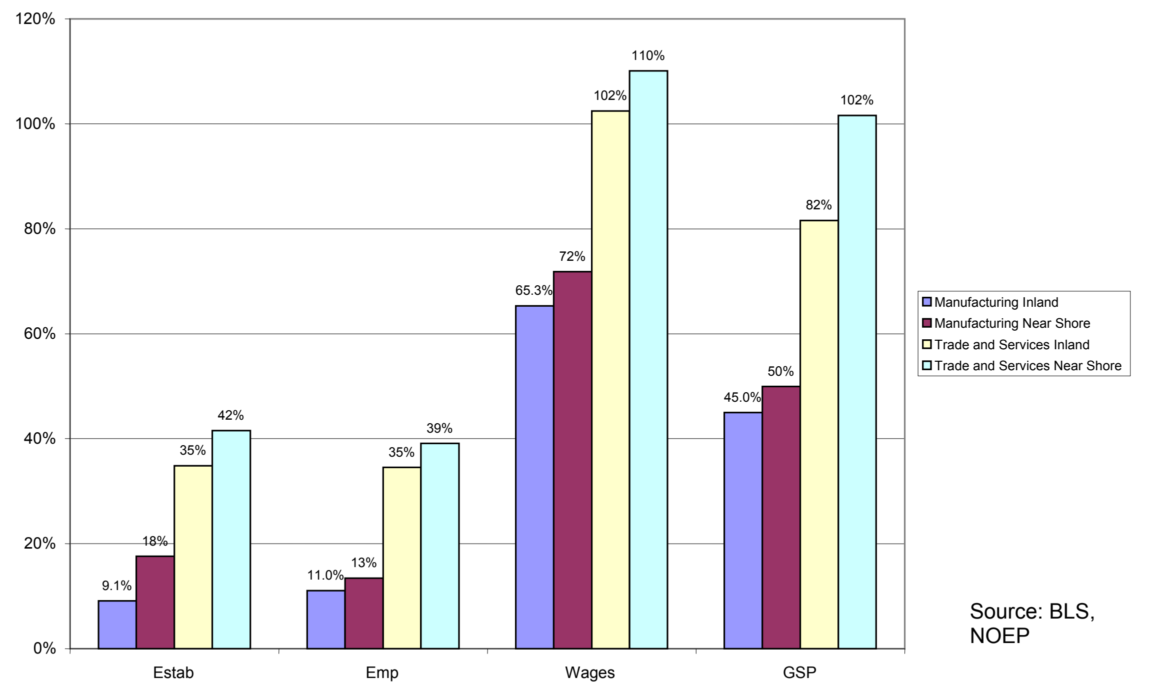
Major conclusions from Table 5 include:

- The coastal states account for about three quarters of the U.S. economy measured by employment and value added in 2000.
- The proportion of the U.S. economy in the coastal states increased from 1990 to 2000.
- Coastal watershed counties account for just under half of the U.S. economy and coastal zone counties for about one-third of the economy.
- All of the tiers of the coast, from the near shore area to the coastal states, grew faster than the U.S. economy over the past decade.
- With 4.6% of the U.S. land area, the coastal near shore region had more than 11% of the U.S. economy in 2000.
- The near shore area was also the fastest growing area of the coast from 1990 to 2000, which grew faster in employment, wages, and value added than coastal zone or coastal watershed counties.

This comparatively rapid growth in the *economy* of the near shore area is in marked contrast to the relatively slower growth of the *population* in this area, suggesting the socio-economic pressures on the near shore area arise from more than population growth. From 1990-2000, the population of the near shore region grew by 3.6 million (see Table 1), but the number of jobs grew by more than 3.8 million.

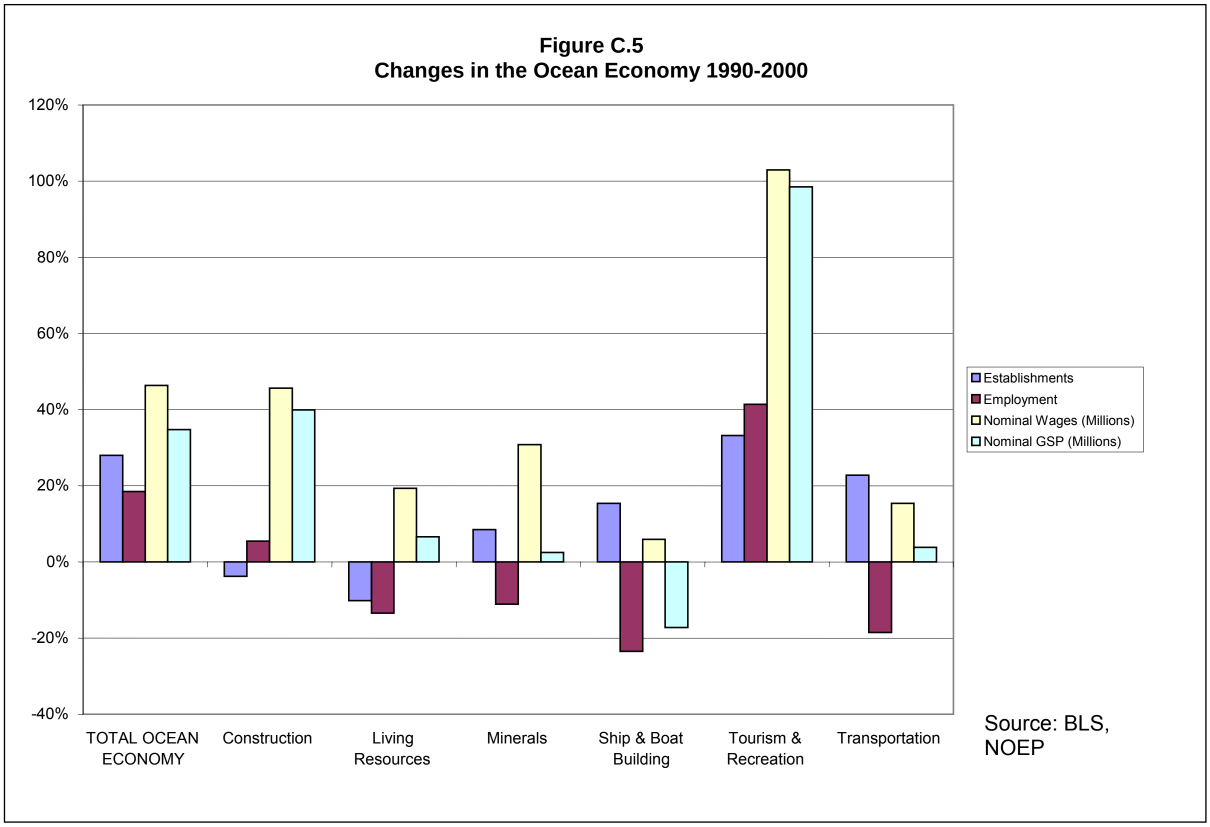
In sum, the economic trends over the past decade have generally shown greater emphasis on coastal regions, with the fastest growth occurring in the areas near the shore. While much of the discussion of the relationship between socioeconomic trends and the health of coastal and ocean resources has concentrated on population growth, the effects of growth in economic activity have been ignored. But economic activity, the growth in employment and output in the near shore area may be even more important than pure population growth. To understand why requires understanding of the composition of growth.

Figure C.4
Economic Growth 1990-2000 By Inland and Near Shore



From 1990-2000 the United States gained 22 million jobs.[12] Despite overall economic growth, manufacturing jobs declined by over 600,000, while trade (wholesale and retail) plus services grew by nearly 17 million, accounting for nearly 80% of the job growth. The decline in manufacturing industries such as steel production, ship building, and chemicals reduced (often at great expense to local communities) the source of many major environmental impacts in the coastal area. Their replacement by hundreds of thousands of smaller establishments in the services and trade industries has allowed employment growth to continue, and even accelerate. But the sum total of those additional establishments has required more and more land for buildings, parking, roads, and other infrastructure, placing proportionately an even heavier demand on coastal lands and resources than the "old" economy.

This shift in the nature of the economy has also greatly affected how we earn our living from the ocean. Table 6 shows the data for the private sector ocean economy of the United States for 1990-2000, while Figure 5 highlights changes in the ocean economy over the same period. The government and scientific research sectors are not included in the ocean economy because of data limitations, so the discussion in this paper is limited to the private ocean economy.[13]



Overall in 2000, the ocean economy accounted directly for 1.6% of employment and 1.4% of the total U.S. private economy. While these may seem like small proportions, they should be considered in context:

- The ocean economy would be the 27th largest state economy in the nation in 2000.

- In 2000, the ocean economy was almost 2.5 times larger than the agricultural economy in terms of output, and over 150% larger than employment in the farm sector. This employment figure for the ocean sector does not include employment in fisheries harvesting.[14]

- In employment, the ocean sector is larger than every manufacturing industry.[15]

The ocean economy has followed this overall pattern of growth in the U.S. economy, shifting away from goods-oriented and towards service oriented production. From 1990 to 2000 there were sharp declines in establishments and employment in the living resources, minerals, and ship and boat building industries, while there was a substantial increase in the establishments and employment in the tourism and recreation sector. The heavy construction sector located in coastal areas grew by 36% in output, but employment grew by only 4% from 1990-2000. It should be noted that this sector is poorly measured under the Standard Industrial Classification system and is subject to strong influence from the business cycle when measured at any two particular years. (Colgan 2003)

The dramatic shift towards tourism and recreation and away from the goods producing sectors has many causes. The growth in tourism and recreation is clearly consistent with long term increases in overall affluence and increases in leisure time. The enduring appeal of the ocean as a source of recreation has not only been sustained, but enhanced by the rise of such industries as cruise ships.[16] At the same time there have been substantial changes in the goods producing sectors.

- The *ship building* industry was at a post-World War II peak in employment in 1990 as the end of the Reagan-era naval expansion was occurring. Since almost all ship building in the United States is done for the Navy, the end of the Cold War and the subsequent reduction in ship procurement for the Navy had a profound effect on this industry. Shipbuilding employment declined by 37% between 1990 and 2000, while output declined by 12%. There was a significant increase in boat building employment (35%) and output (82%), primarily for the recreational market, but this was not enough to offset the decline in employment in ship building.

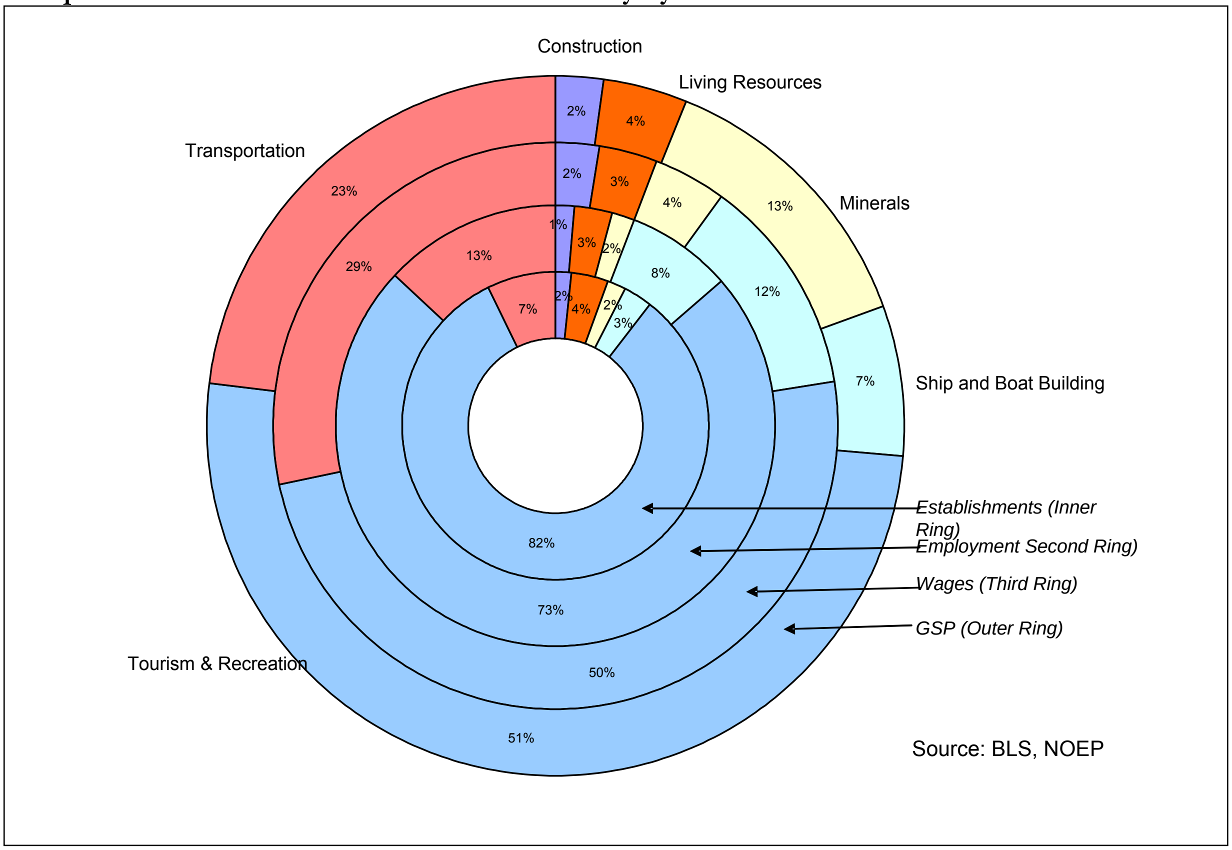
- The *living resources* sector saw dramatic declines as overfishing in key areas such as New England, the Pacific, and Gulf of Mexico led to enforced reductions in fishing effort. While the fisheries harvesting sector is not fully reflected in these figures[17], the overall trend towards declines in employment and output in this sector is clear. Seafood processing employment, which will mirror trends in seafood harvesting, declined by 11%. The value of output in the seafood processing industry rose (by 34%) as declining catches resulted in higher-valued output. Those declines were only slightly offset by the growth of aquaculture, which grew by 30% in employment and 26% in output, but remains a small industry.

- *Minerals* production, primarily offshore oil and gas, declined somewhat over the decade as older fields in the Gulf of Mexico were played out. Employment fell by 11% while contribution to gross state product grew slightly (2.5%). More importantly, there was a reduction in the number of employees needed in the oil and gas industry as more and more technology was employed to find and produce the ocean's mineral resources. The relatively small coastal limestone, sand & gravel industry did show significant growth, nearly doubling in employment and more than doubling in output. This was most probably due to increasing demand for construction aggregates for the foundations of new homes, commercial buildings, and roads throughout the coastal states.

- Ocean related *transportation* declined in employment, but grew in importance. The declines in employment were primarily in deep sea freight handling (down 31%) and in search and navigation equipment (down 42%). In the case of marine freight handling industries, the volume of ocean-going trade increased over the decade but the number of people required to handle the trade declined as containers and automation allowed fewer people to work the docks. The decline in search and navigation equipment was heavily related to post-Cold War military procurement reductions. On the other hand, ocean related passenger transportation increased significantly (up 62% in employment and 133% in GSP), from cruise ships, ferry services and tour boats[18].

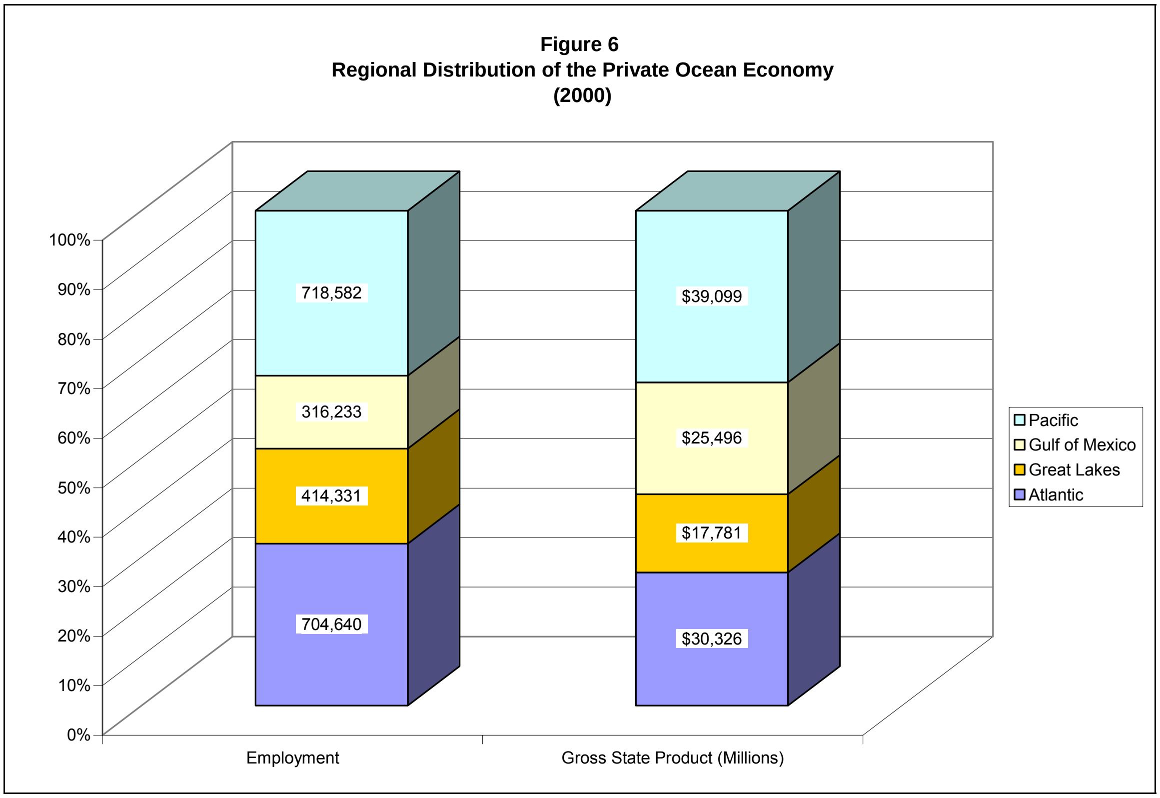
The changes in the ocean economy away from goods-producing activities should, not, however, obscure the continued importance of goods-related activities. Figure 4 compares the distribution of establishments, employment, wages, and output from the ocean sectors for 2000. Tourism and recreation dominates the number of establishments and employment, with three quarters or more of the ocean economy accounted for by this sector. When wages and output are considered, the goods producing industries are much more important, particularly the minerals sector. Accounting for 2% of employment, minerals accounts for nearly ten times the proportion of ocean economy output.

Figure C.5
Composition of the Private Sector Ocean Economy by Different Measures: 2000



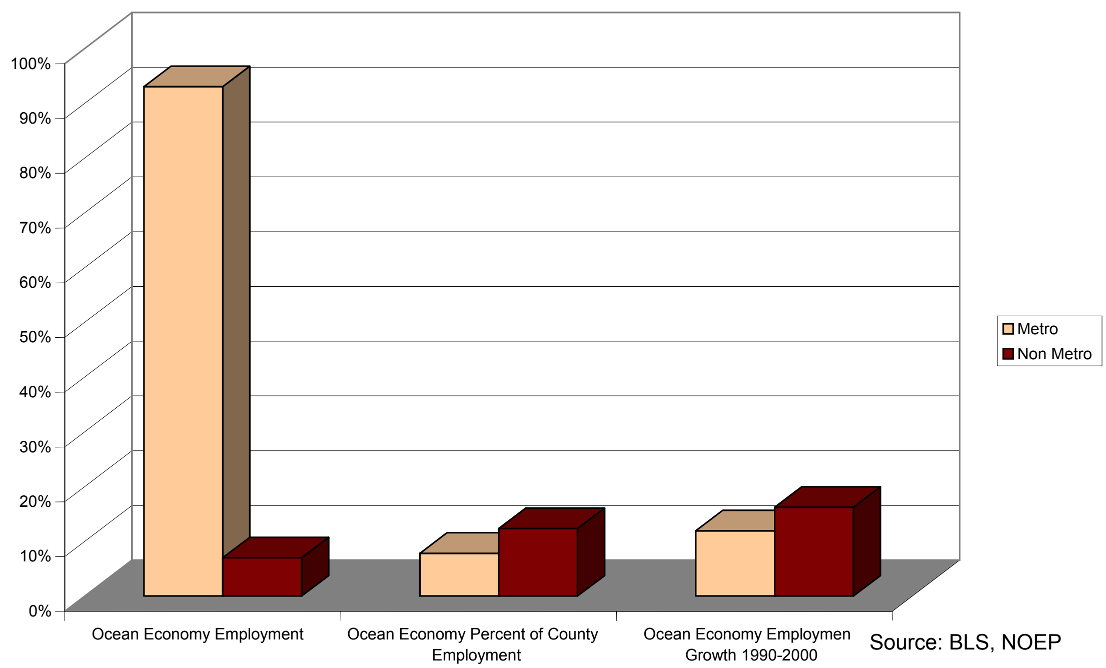
This difference in importance based on which measure is used also influences which of the coastal regions of the U.S. can claim the largest share of the ocean economy. Figure 6 shows the distribution of the ocean economy in 2000 by both employment and output. The Pacific region is the largest region on both measures, with 34% of employment and output. The Gulf of Mexico region accounts for 15% of employment and 22% of output because of the large contributions to gross output by the minerals sector, which is concentrated in the Gulf of Mexico.

Figure C.6



The geographic distribution of the ocean must also be considered in terms of the ocean economy's role in both urban and rural locations. (Figure 7) The ocean economy is overwhelmingly an urban economy; 93% of employment in the ocean industries is in metropolitan area counties, and two thirds of employment is in counties in metropolitan areas with a total population of one million or more.[19] It is perhaps not surprising that the ocean economy is very much an urban economy given the large number of America's principal cities that exist on the coast, but the extent of the concentration of what is a natural-resource based economy in the urban centers of the U.S. speaks to a unique role of the ocean in the American economy. Of all the major natural resources such as farmland and forests, the oceans and Great Lakes are the only resource so intimately connected to the cities, rather than just the country.

Figure C.7
Metro-Non Metro Distribution of Ocean Economy



Source: BLS, NOEP

However, the importance of the ocean economy to rural economies should not be lost. While the employment in the ocean economy is overwhelmingly urban, it comprises less than 8% of the economy in urban areas, but more than 12% of the economy in rural counties. Moreover, the growth rate in ocean sector employment in rural counties over 1990-2000 was one third faster than in urban counties (16% in rural counties v. 12% in urban counties). Recalling that almost all of the growth in employment occurred in the tourism and recreation sector, the increasing importance of the ocean economy in rural counties is closely tied to their roles of providing an escape for urban dwellers looking for recreation.

Summary of Economic Trends

Total economic activity on the coast accounts for a substantial portion of the American economy. Over three quarters of U.S. domestic economic activity takes place in the coastal states, and nearly half in the coastal watershed counties. The proportion of economic activity in the near shore area is more than twice the proportion of land area, and the total volume of economic activity in the near shore area may have a more profound effect on coastal resources than the more frequently cited figures about population pressures.

The ocean economy is a small proportion of America's huge 10 trillion dollar economy, but it is still larger than all but the largest state economies. At over $117 billion in 2000, it represents a significant level of economic activity. But the way in which we use the ocean is changing dramatically and rapidly.

Mirroring larger trends in the economy, the services of tourism and recreation have provided almost all the growth in employment and much of the growth in wages and output, while goods related sectors such as the fisheries, transportation, ship and boat building, and minerals have declined in employment and their growth in wages and output have lagged behind the overall economy. All of the ocean economy sectors remain important to the nation, and a major focus of policy towards the use of the ocean must be to balance the demands of a fast growing tourism and recreation sector with the needs of still-vital uses of the sea for living resources, minerals and fuel, transportation, and ship and boat building. Conflicts over the uses of the scarce coastal and ocean resources will only increase in intensity in the future given these trends.

Most of the employment in the ocean economy is to be found in urban areas, where the competition for land and the impacts of human activity are at their greatest, but where the ocean provides a key component making our cities both competitive and livable. At the same time, the ocean economy plays a proportionately much larger role in the rural regions of the U.S., where overall economic growth has been much slower. The vitality of rural areas on the coast remains very much tied to the sea.

5. The Coastal and Ocean Economy Beyond the Market Place

The preceding analysis examines the role of ocean and coastal economic activity using the conventional measures of employment, wages (income), and output. These measures tell a vital, but incomplete story of the role of ocean and coastal resources in the economic life of the nation. What is left out is are the economic values associated with a family spending a day at the local beach, or of surfers or sailors who are passionate about their use of the oceans, which may result in little spending each year that winds up being measured in the national income accounts but is an essential part of peoples' economic lives. Also missing are the economic values that natural resources such as estuaries or coral reefs perform as nurseries for fisheries as natural pollutant cleansing mechanisms and buffers against storm damage.

These economic values are very real, but are not measured as systematically as with market transaction-based economic activity. Economists have made substantial progress in developing methods to measure these values, but studies of these "non-market" values are sporadic. Some types of resources, such as recreational resources, have been studied regularly, but only some coastal regions have been studied and many areas have never been examined. Other resources are studied only when damaged by events such as an oil spill for purposes of federal law.[20] The result is that it is not possible to provide an overview of these economic values of the ocean and coasts, but only to provide examples of these values and why they are important.

Estuaries are perhaps the most diverse of coastal environmental systems, and so are recognized as being among the most valuable. A number of studies have been done of the economic values associated with estuaries, particularly those which are covered by the National Estuary Program administered by EPA. One such study of the Indian River Lagoon area of Florida examined the economic values associated with recreational fishing in the region, as well as resident's willingness to pay to restore and enhance the Lagoon's environmental quality. (Apogee Research and Resource Economic Consultants 2000) Estimates of the value of marine recreational fishing in excess of expenditures range from $100 to $589 per angler, resulting in an estimate of $140 million per year in recreational fishing values. This figure is limited to the residents of the five-county region around the Lagoon, and does not include recreational anglers from other areas.

This study also examined the willingness to pay to improve the environmental quality of the estuary through programs such as stormwater management, protection of wetlands, and acquisition of lands for conservation purposes. The median values of these actions per household were estimated to be $40, $25, $19, and $29 respectively. These values were reported whether or not those asked actually used the Lagoon or not. Aggregated across the population of the five-county region, the value of the environmental quality of the Indian River Lagoon was found to range between $14.6 million to $25.9 million depending on which package of environmental improvements residents were asked to value.

Coral Reefs are also one the most important marine resources and one of the most threatened. Understanding the economic value of the reefs has become an important element in developing restoration and management strategies. A recent study (Cesar, Beukering et al. 2002) of parts of the reef systems in the Hawaiian Islands estimates the values of the rich coral reefs of that state to be at least $384 million per year. The vast majority if this benefit is from tourism and recreation, but it also derives from the enhanced value of real estate in areas bordered by coral reefs, the value of the biodiversity of the reef ecosystems, and the values of enhanced commercial and recreational fisheries productivity.

Estimating the **value of lost resources** from events such as oil spills has become an integral part of the response to such disasters. One of the most important of such estimates was the study of the value lost to Americans from the damages caused by the grounding of the tanker *Exxon Valdez* in 1989. Studies done for the State of Alaska (Carson, Mitchell et al. 1992) found that Americans were highly aware of the damage from that spill, and were willing to pay to avoid the losses caused by that oil spill. These studies found a median willingness to pay to avoid the damages of $31 per household, or about $2.8 billion for the U.S. as a whole. This study became the basis for the litigation and a settlement arising from what was the largest oil spill in U.S. waters.

The value of beach recreation Beaches are among the coast's most important recreational resources. Their economic value is comprised of the expenditures that visitors make to visit the beach and the value to the beach-goer over and above what they spend. A significant body of research has attempted to measure these values. While the research methods and approaches have differed, most of the research has shown that the non-market values of the use and enjoyment of beaches are significant.

Southern California has among the most famous beaches in the world. The beaches of Orange County attract upwards of 150,000 visits per day in the summer. Studies of the value of use and enjoyment[21] of southern California beaches range from $18.00 per day for Santa Monica beaches to $23.00 per day for Huntington Beach. (Hanneman 2001) The beaches of Ohio are less well known, but just as important to the residents and visitors. Studies of the northern Ohio beaches of Headlands State Park and Maumee Bay found values similar to California of $15.60 per day for the former and $25.60 per day for the latter. (Sohngen, Lichtkoppler et al. 1999) Summed over a year, the value of using Santa Monica beach is estimated at over $200 million for the 12 million visitors to these beaches. The comparable value for Huntington Beach is over $12 million, while the Ohio beaches are valued at $6.1 million (Maumee Bay) and $3.5 million (Headlands) based on the lower number of visitors. These studies illustrate both the potential size of the non-market values of beaches, and the lack of data which exists in many other beach-oriented coastal regions from Maine to Hawaii.

Because of the complexities in estimating these non-market values, it will probably never be possible to compile a single picture of these values of the ocean and coasts in the same way we can with measures such as employment, wages, and output. But these illustrations show that these non-market values are often large and understanding them is vital to our ability to manage ocean and coastal resources to best advantage.

6. Implications

The changes in the coastal and ocean socio-economic environment that have been underway will shape policy for the coasts and oceans in a number of important ways. Much of the health of the oceans depends on what happens on the land, as the Stratton Commission recognized. Shaping policy towards the management of the land and water resources of the coastal areas will have to take into account the increases in population density throughout the coast, but also the faster population growth in upland areas and the faster economic and employment growth near the shore. The upland areas of watersheds require more attention as a result of the first trend, while the impacts of rapid commercial growth near the shore require attention as a result of the second.

Population impacts must also be reconsidered as resulting from more than the people who live on the coast. The real population growth on the coasts is not from permanent residents near the shore but the large number of people who come to the shore for short periods of time. These include the large number of employees who must commute into the near-shore region to take the growing number of jobs there but who cannot live there because of high real estate prices. It also includes people who commute to the near shore area for shopping or to utilize the growing retail and service industries there. Finally, it includes large numbers of tourists and recreationists who increase the population in coastal areas several fold, primarily in the summer. These populations are poorly measured, but are clearly implied by the trends in the economy and housing.

The sum of the "short term" and "resident" populations means that the public must plan for and build a transportation infrastructure to serve a much larger population in coastal areas than actually live there. Because of rapid employment growth in near shore areas, transportation infrastructure must have the capacity to move employees on a daily basis and tourists on a seasonal basis. This large transportation infrastructure must be provided in such a way that it minimizes impacts on the very resources that make the coast special, and allows community character to be maintained.

The complex dimensions of population, housing, and economic changes are clearly challenging federal, state, and local agencies. Inevitably questions arise about whether the high degree of both functional and geographic fragmentation in the jurisdictions of public agencies is a barrier to effective policy. Such concerns lead often lead to calls for new "regional" levels of government, in which jurisdictions match appropriate ecological and socio-economic boundaries. The question of matching jurisdictions with responsibilities is an important one.

While new forms of organizations may be needed in some cases, there are a number of organizations integrating federal, state and local governments with responsibilities appropriate to managing coastal and ocean resources. These include coastal zone management agencies under the Coastal Zone Management Act, the National Estuary Programs established under the Clean Water Act, and the Metropolitan Planning Organizations established under the Intermodal Surface Transportation Efficiency Act. These organizations can play an important role in addressing many of the issues raised by the evolution of socio-economic trends discussed here and the changes in the natural environment noted in other information provided to the Commission.

The changes in the ocean economy point to a number of different conclusions:

Fisheries It is clear that the severe problems with America's fisheries resources have had significant negative effects on the economy of many communities. The losses in jobs reflected in the processing industry figures reported here are magnified several times in the unreported employment figures of harvesting sector employment. While many fisheries remain vital sources of employment and economic output, a significant restoration of abundance in fish stocks to sustainable levels will provide important economic boosts to many regions. Aquaculture is also an important new industry, but it does not appear to be replacing the employment levels lost in the capture fisheries.

Maritime Transportation The role of the maritime transportation industry in the economy is changing dramatically. While the volume of goods being moved across the oceans and along the coasts comprises a large and growing share of the American economy, competitive pressures on the transportation industry and improved technologies are reducing the demand for labor, particularly in the handling of freight. Expansions and improvements to maritime freight transportation will continue to be a key to the success of the ocean and national economies.

The rapid growth of the cruise ship industry, now operating in virtually all coastal regions, represents both an important new dimension to the marine transportation industry and is a part of the rapidly growing tourism and recreation industry. The cruise ship industry offers both significant economic development opportunities to the communities served by the industry and new challenges in community planning and environmental management as the equivalent of major resort hotels move up and down the coast.

Minerals The offshore oil and gas industry remains an important source of energy for the nation, albeit a controversial one. Like maritime transportation, employment in this industry is declining as efficiency improvements and changing output levels affect the industry. Also like maritime transportation, offshore oil and gas will continue to play an important part in the economy. Uses of other ocean minerals, like sand and gravel, are not currently large enough to play a significant role in the ocean economy, but may play a larger role in the future.

Tourism and Recreation The explosive growth of coastal and ocean tourism and recreation dominates the story of the ocean economy over the last decade, and this is likely to be the case for the foreseeable future. The growth in tourism and recreation is part of the reason for the rapid growth in employment and economic activity in the near shore regions, meaning that the issues discussed above concerning those trends are part of the story of tourism and recreation growth. Seasonal population and housing growth is also part of the story. While much attention has been devoted to promoting sustainable forms of "ecotourism" in coastal regions, it is clear that it is the overall growth of tourism and recreation activities in coastal areas that requires the greatest attention. There is also likely to be an increasing tie between population growth and tourism and recreation growth in coastal areas. As the baby boom generation moves into retirement in the next two decades, many will seek to permanently re-locate to the coastal regions where they have previously enjoyed vacations. Many coastal regions will develop sharp age structure imbalances, coming to be dominated by retirees and the aged.

7. The Future of Understanding the Coastal and Ocean Economy

Despite the size and importance of the ocean and coastal economy, the Federal government invests very little in trying to monitor and understand it. While the National Marine Fisheries Service and the Special Projects Office have ongoing economic research programs, they are limited to generating information directly related to NOAA programs. There is no organization with a general purpose economic research program or funding within NOAA comparable to the Economic Research Service in the Department of Agriculture, which has an annual budget of over $100 million. None of the major economic statistics agencies of the Federal government, including the Department of Commerce's Bureau of the Census and Bureau of Economic Analysis or the Department of Labor's Bureau of Labor Statistics, have either mandate or money to study the ocean and coastal economy.

The economic statistics cited in this report are the result of a NOAA and EPA-sponsored National Ocean Economics Project, a multi-year research study being conducted at several universities. This research program is providing critical information, but research is not a substitute for the kind of ongoing commitment to generating data that can be used to monitor and study the coastal and ocean economy. As part of its recommitment to ocean policy, the Federal government needs to establish an ongoing program of using its existing statistical resources to continue the measurement of the coastal and ocean economy and to generating additional data resources and analysis in this field.

A sustained effort to monitor and improve understanding of the coastal and ocean economy requires a cooperative approach among a number of different federal and nonfederal organizations. Seven organizations will play key roles.

1. **NOAA**. As the principal federal agency with responsibility for the oceans, NOAA must play the lead role, working with other agencies to set agendas for research and publication of data, as well as enhancing the use of economic data to assist decision making at the federal, state, and local levels.

2. The **Bureau of Labor Statistics**. BLS, in cooperation with the states, collects the most basic employment and wage data on the economy. The economic data presented here is based on the Longitudinal Data Base maintained by the Bureau. This data will continue to be the fundamental element of monitoring the coastal and ocean economy from national to local levels.

3. The **Bureau of the Census** is the other major collector of primary data on the economy, including the censuses of population and housing and of the major sectors of the economy. The Department of Agriculture has responsibility for the Census of Agriculture, which includes data on aquaculture.

4. The **Bureau of Economic Analysis**. BEA uses data inputs from the data collecting agencies to maintain the most important measure of annual economic activity, the national income and product accounts, the best-known element of which is the gross domestic product. Related measures such as the gross state product are key to understanding regional economies, as is the measurement of self employment.

5. **EPA**. The Environmental Protection Agency undertakes substantial economic research in the fields of land, water, and air pollution that affect ocean and coastal resources at many points. EPA's economic research focuses particular attention on nonmarket values, and provides an important supplement to NOAA's work in this area.

6. The **National Science Foundation** is the provider of support for much of the basic research in the sciences, including the social sciences. It has recently undertaken new initiatives to better link the natural and social sciences in the aid of improved management of the environment and natural resources, which fits well within the framework of socio-economic research on the coasts and oceans.

7. **Universities and Other Researchers**. As with marine science in general, the key research in measuring the coastal and ocean economy is a cooperative arrangement between the federal government and researchers in the nation's universities and in private research organizations. The interaction among federal, academic, and private researchers, with the federal government providing a key catalytic role with funding, takes advantage of the strengths of multiple perspectives and organizational missions.

The future of socio-economic information for the coasts and oceans will require the successful creation of a network among these and other organizations who are concerned with the coasts and oceans. That network must be built around the following functions:

- *Data Collection*. Standard measures of employment, income, and output for the ocean and coastal economy need to be developed and maintained. The work by the National Ocean Economics Project provides the foundation for this work. In addition, special measures must be developed for the unique aspects of the coastal and ocean economy. In particular, the influence of the coasts and ocean on land values needs to be understood throughout the range of different coast types. The vital role of the oceans in tourism and recreation needs to be better understood in terms of both market and nonmarket values, and the economic values of the ecosystem service roles of the coasts and oceans better measured.

- *Data Distribution*. Data must be collected, but they must also be widely distributed both to be available to policy makers to factor into decisions and to spur further research. The availability of contemporary database and Internet delivery systems makes this function easier and cheaper than ever.

- *Data Analysis* Data are only useful when they are transformed into information through analysis. Data analysis should be driven in large part by the needs to support decision making at the federal, state, and local levels about the management of ocean and coastal resources. This will mean both analysis of socio-economic trends on their own, and, increasingly, the ability to analytically link changes in the socio-economic sphere to changes in the environment, and vice versa.

- *Education and Research*. Outside of the fields of fisheries and mineral economics, the field of ocean and coastal socio-economic studies is still relatively new and confined to a fairly small group of specialists. There must be an expansion of the field through training of both researchers and policy specialists to generate and use this information. Research must also continue to improve our measurement of non-market values, to develop measures of the use of coastal and ocean resources such as beaches, and to improve the data systems for standard measures such as employment and output. Current work in these areas represents a beginning, not an end to these endeavors. The advent of geographic information systems also substantially eases the integration of socio-economic with natural resource data, and this integration needs to be another focus of research so that the interactions between the human and natural environments in the coastal areas can be better understood.

Given these resources and needs, the federal government should commit to an ongoing program of socio economic research of trends and values of the nation's coasts and oceans. That program should include the following elements:

- Designation of a specific socioeconomic research and data collection function within NOAA.

- An interagency group, chaired by NOAA, of researchers and data providers in the federal agencies concerned with data for the coasts and oceans.

- An Advisory Board, reporting to NOAA and the interagency group, of outside researchers with appropriate expertise, to help set agendas, design programs, and evaluate progress.

- A statutory requirement that the Bureau of Labor Statistics and Bureau of Economic Analysis prepare an annual report on the employment, wages, and output associated with the coasts and oceans of the United States.

- A special effort to make available key data that are missing from the current suite of economic statistics, particularly employment and incomes in the fisheries harvesting sector.

- Regular funding for research into improved measures of both the market and non-market economic values of the coasts and oceans. An area of particular importance is establishing the economic value of the nation's ocean and coastal resources as assets in which we invest.

- An Internet based data archive and distribution system that links key sources of coastal and ocean socioeconomic data and research.

Funding for these efforts should be in the $8-10 million range annually, with funds provided to both data using and data providing agency for sufficient staff and other costs. This is particularly the case for the data providing agencies such as the Bureau of Labor Statistics, Bureau of the Census and Bureau of Economic Analysis who cannot play their roles without additional resources. Partnership arrangements with nonfederal organizations like the National Ocean Economics Project should be maintained and expanded.

It should be noted that at a time of scarce budgetary resources, this amount may seem like a substantial sum. But it is less and than 1/10th of what the federal government currently spends on economic research in the agriculture sector, which is actually smaller than the ocean sector in the overall economy.

TABLES

Table C.1 Population Change in the Three Tiers of the Coast

	Population (Millions)			
	1970	1980	1990	2000
United States	202.55	225.90	248.16	280.85
Coastal Watershed Counties	107.99	117.56	130.89	145.49
Coastal Zone Counties	75.51	82.87	92.94	103.59
Near Shore*			35.26	39.11

	Change							
	1970-80		1980-90		1990-2000		1970-1990	
	N (millions)	Percent	N (millions)	Percent	N (millions)	Percent	N (millions)	Percent
United States	23.36	11.5%	22.25	9.9%	32.69	13.2%	78.30	38.7%
Coastal Watershed Counties	9.58	8.9%	13.33	11.3%	14.60	11.2%	37.50	34.7%
Coastal Zone Counties	7.36	9.7%	10.08	12.2%	10.64	11.5%	28.08	37.2%
Near Shore*					3.85	10.9%		

* Data available only for 1990 and 2000

Source: US Census

Table C.2 Population Density in the Coastal Regions

		Percent of U.S.			Population Density (Persons per Square Mile)	
	Land Area*	Area	Population 1970	Population 2000	1970	2000
United States	3,537,377	100.0%	100.0%	100.0%	57.3	79.4
Coastal Watershed Counties	871,216	24.6%	53.3%	51.8%	124.0	167.0
Coastal Zone Counties	663,528	18.8%	37.3%	36.9%	113.8	156.1
Near Shore*	164,113	4.6%		13.6%		232.6

*In Square Miles. Excludes surface water area such as wetlands, lakes, and rivers)

Source: US Census

Table C.3 Population in Coastal Tiers by Coastal Region

		Population* (Millions)			
		1970	1980	1990	2000
United States Total		202.55	225.90	248.16	280.85
Atlantic	Coastal Watershed Counties	39.22	41.32	45.49	50.41
	Coastal Zone Counties	28.47	30.54	34.21	38.47
	Near Shore**			14.2	15.7
Gulf of Mexico	Coastal Watershed Counties	13.18	15.70	17.80	20.95
	Coastal Zone Counties	6.12	8.32	9.95	11.77
	Near Shore			6.0	7.1
Pacific	Coastal Watershed Counties	22.84	26.95	33.21	37.92
	Coastal Zone Counties	20.84	24.41	29.6	33.30
	Near Shore			8.1	8.9
Great Lakes	Coastal Watershed Counties	30.34	30.30	30.36	32.04
	Coastal Zone Counties	20.06	19.67	19.21	19.99
	Near Shore			5.40	5.52

		Change							
		1970-80		1980-90		1990-2000		1970-2000	
		N (millions)	Percent	N (millions)	Percent	N (millions)	Percent	N (millions)	Percent
United States Total		23.36	11.5%	22.25	9.9%	32.69	13.2%	78.30	38.7%
Atlantic	Coastal Watershed Counties	2.10	5.4%	4.17	10.1%	4.92	10.8%	11.19	28.5%
	Coastal Zone Counties	2.07	7.3%	3.67	12.0%	4.26	12.5%	10.00	35.1%
	Near Shore					1.50	10.3%		
Gulf of Mexico	Coastal Watershed Counties	2.52	19.1%	2.10	13.4%	3.15	17.7%	7.77	59.0%
	Coastal Zone Counties	2.20	35.9%	1.63	19.6%	1.82	18.3%	5.65	92.3%
	Near Shore					1.10	18.3%		
Pacific	Coastal Watershed Counties	4.11	18.0%	6.26	23.2%	4.71	14.2%	15.08	66.0%
	Coastal Zone Counties	3.57	17.1%	5.19	21.3%	3.70	12.5%	12.46	59.8%
	Near Shore					0.80	9.9%		
Great Lakes	Coastal Watershed Counties	-0.04	-0.1%	0.06	0.2%	1.68	5.5%	1.70	5.6%
	Coastal Zone Counties	-0.39	-1.9%	-0.46	-2.3%	0.78	4.1%	-0.07	-0.3%
	Near Shore					0.12	2.2%		

*Data available only for 1990 and 2000

Source: US Census

Table C.4 Population Growth by Coastal Tier and Urban/Rural County

	Population (Millions)					
	Urban			Rural		
	1970	1990	2000	1970	1990	2000
Coastal Watershed Counties	100.82	121.69	135.13	7.16	9.19	10.36
Coastal Zone Counties	73.15	90.69	101.38	3.75	5.12	5.89
Near Shore		31.58	34.87		2.97	3.29

		Change			
		1970-2000		1990-2000	
		N (millions)	Percent	N (millions)	Percent
Urban	Coastal Watershed Counties	34.31	34.0%	13.44	11.0%
	Coastal Zone Counties	28.23	38.6%	10.69	11.8%
	Near Shore			3.29	10.4%
Rural	Coastal Watershed Counties	3.20	44.7%	1.17	12.7%
	Coastal Zone Counties	2.14	57.1%	0.77	15.0%
	Near Shore			0.32	10.8%
Source: US Census					

Table C.5 Total Coastal Economy

	1990			
	Establishments	Wage & Salary Employment	Wages (Millions)	Gross State Product (millions)
Total U.S. Economy	NA	109,043,000	$2,743,643	$5,706,658
Total Coastal States	4,998,116	76,477,272	$1,850,303	$3,887,225
Coastal Watershed Counties	3,101,001	49,068,567	$1,246,219	$2,584,802
Coastal Zone Counties	2,267,894	36,359,010	$884,366	$1,865,741
Near Shore*	776,991	10,784,785	$264,346	$558,634
	2000			
	Establishments	Wage & Salary Employment	Wages (millions)	Gross State Product (millions)
Total U.S. Economy	NA	131,720,000	$4,834,254	$9,415,552
Total Coastal States	6,495,532	100,452,156	$3,632,333	$7,023,413
Coastal Watershed Counties	3,831,358	60,696,525	$2,334,920	$4,512,357
Coastal Zone Counties	2,906,685	44,659,916	$1,698,336	$3,264,539
Near Shore*	1,065,576	14,574,973	$536,196	$1,058,596
	Percent Change 1990-2000			
	Establishments	Wage & Salary Employment	Wages	Gross State Product
Total U.S. Economy	NA	20.8%	76.2%	65.0%
Total Coastal States	30.0%	31.3%	96.3%	80.7%
Coastal Watershed Counties	23.6%	23.7%	87.4%	74.6%
Coastal Zone Counties	28.2%	22.8%	92.0%	75.0%
Near Shore*	37.1%	35.1%	102.8%	89.5%

Sources: Bureau of Labor Statistics, Bureau of Economic Analysis, National Ocean Economics Project.

Table C.6 Private Ocean Economy

1990				
Ocean Economy Sector	Establishments	Employment	Wages (Millions Current $)	Gross State Product (Millions Current $)
TOTAL	91,203	1,924,014	$38,064	$87,074
Construction	2,144	30,198	$937	$1,854
Living Resources	5,098	71,819	$1,540	$4,421
Minerals	1,829	45,099	$1,860	$15,043
Ship & Boat Building	3,192	230,097	$6,564	$9,769
Tourism & Recreation	71,958	1,182,809	$13,447	$29,978
Transportation	6,982	363,992	$13,716	$26,008
2000				
TOTAL	116,736	2,279,006	$55,704	$117,318
Construction	2,064	31,835	$1,364	$2,594
Living Resources	4,580	62,184	$1,838	$4,714
Minerals	1,984	40,097	$2,432	$15,414
Ship & Boat Building	3,684	176,098	$6,952	$8,089
Tourism & Recreation	95,850	1,672,156	$27,292	$59,497
Transportation	8,572	296,634	$15,826	$27,009
Change 1990-2000				
	Establishments	Employment	Nominal Wages (Millions)	Nominal GSP (Millions)
TOTAL	25,533	354,993	$17,640	$30,244
Construction	(80)	1,638	$427	$740
Living Resources	(518)	(9,636)	$298	$293
Minerals	155	(5,002)	$572	$371
Ship & Boat Building	492	(53,999)	$388	-$1,680
Tourism & Recreation	23,892	489,346	$13,845	$29,519
Transportation	1,590	(67,357)	$2,110	$1,001
Per Cent Change 1990-2000				
TOTAL	28.0%	18.5%	46.3%	34.7%
Construction	-3.7%	5.4%	45.6%	39.9%
Living Resources	-10.2%	-13.4%	19.3%	6.6%
Minerals	8.5%	-11.1%	30.8%	2.5%
Ship & Boat Building	15.4%	-23.5%	5.9%	-17.2%
Tourism & Recreation	33.2%	41.4%	103.0%	98.5%
Transportation	22.8%	-18.5%	15.4%	3.8%

Source: Bureau of Labor Statistics, Bureau of Economic Analysis, National Ocean Economics Project

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NOTES

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[1] "Counties" in this context includes not only political jurisdictions that function as counties, including parishes in Louisiana and boroughs in Alaska. It also includes Census-designated areas in some states. These are areas defined by the Census bureau as sub-state regions for statistical purposes even though there is no governmental function. Counties in Connecticut, Rhode Island, and Massachusetts, along with some regions in Alaska fall into this category. In Virginia, independent cities, which have functions to similar to counties, but are not classified as counties under state law, are included when they fall within defined coastal areas.

[2] Boundaries of coastal zone are provided by the Office of Coastal Resource Management, NOAA.

[3] The four states which define the entire state as the coastal zone are Florida, Rhode Island, Delaware, and Hawaii.

[4] Examples of states using county boundaries include Washington, South Carolina, Mississippi, and North Carolina. States using municipal boundaries include Maine and Connecticut. In New York, the coastal zone includes counties along the Hudson River as far north as Albany, as well as counties along both the Atlantic and Great Lakes coasts. Pennsylvania defines its coastal zone only along Lake Erie and not along the Delaware River. In this analysis, Cook County Illinois is included in the coastal zone county definition, although Illinois does not participate in the CZM program to provide complete coverage of the nation.

[5] This figure is based on the decennial census, which measures population on April 1 of the year. It does not include seasonal peak populations, which can be orders of magnitude higher in a number of coastal regions.

[6] The Atlantic region is defined as coastal zone and coastal watershed counties from Washington County, Maine to Miami-Dade County, Florida, including the Chesapeake Bay counties of Maryland and Virginia. New York counties exclude counties on the Hudson River, beginning with New York County. Monroe County, Florida is counted in the Gulf of Mexico region. The Pacific region includes Hawaii and Alaska. Cook county is included in Illinois in the coastal zone definition, although Illinois does not participate in the CZM program.

[7] For purposes of defining urban and rural, the Urban Influence Codes of the Department of Agriculture's Economic Research Service are used. These codes define counties as urban or rural based on the population of the largest city or town, the location within a Census-defined metropolitan area, and the adjacency of the county to largest central city (if in a metro area) or to a metro area. For more information, see http://www.ers.usda.gov/briefing/rurality/UrbanInf/.

[8] "Large community" is defined as a population in 1990 of 20,000 or more.

[9] There have been periodic attempts over the past three decades to define an ocean economy, beginning in the 1970's when the Bureau of Economic Analysis sponsored the first estimation of the "ocean economy". This work was updated by Pontecorvo See Pontecorvo, G., M. Wilkinson, et al. (1980). "Contribution of of the Ocean Sector to the U.S. Economy." Science **208**(30): 1000-1006.}and extended somewhat in a later study of the coastal economy by Luger See Luger, M. (1991). "The Economic Value of the Coastal Zone." Environmental Systems **21**(4): 278-301.A number of state and regional agencies have undertaken studies of local coastal economies in order to better understand the role of the ocean and coasts in their areas (e.g. Colgan, C. S. and J. Plumstead (1993). Economic Prospects for the Gulf of Maine. Augusta, ME, Gulf of Maine Council on the Marine Environment, Moller, R. and J. Fitz (1997). California's Ocean Resources: An Agenda for the Future. Sacramento CA, California Resources Agency.).

[10] The National Ocean Economics Project is funded by NOAA and EPA. It involves researchers at the University of Southern California, University of Vermont, and University of Southern Maine. For more information see www.oceaneconomics.org

[11] Establishments are "places of business", not firms. A firm may operate many establishments. Employment is defined as wage and salary employment in industries covered by the unemployment

insurance laws. This definition excludes self employment, many of the employees in the railroad industry (who are covered under a separate federal statute), and farm employment. It also excludes harvesting sector employment in the fisheries. The Living Resources sector excludes harvesting sector employment, which is not collected nationally. Data for 1990 and 2000 are the only two years for which data on the ocean economy is currently available.

[12] Wage and salary jobs. Source: Bureau of Economic Analysis.

[13] Government employment is measured as total employment in government agencies and does not differentiate by type of function. Thus it is not possible to distinguish ocean related from non-ocean related government activities. Marine science organizations are, for the most part, separately reported from other science and research organizations and universities.

[14] Measured as farm proprietors. Source: BEA.

[15] Defined as two-digit SIC classifications.

[16] The cruise ship industry is also poorly measured in the economic statistics. The cruise ships themselves are foreign owned and foreign crewed thus do not show up in the U.S. gross state product figures. The principal measure of the cruise ship industry is thus the shore-side employment of support organizations who provide food, fuel, and other services. Consumer expenditures on cruise ships are measured in the gross domestic product within overall consumption, but cannot be separated out in this analysis of production.

[17] Employment in the harvesting sector of the commercial fishing industry is not included in any government statistics programs because this industry is excluded from the unemployment insurance laws. Occasional estimates of harvesting employment have been made for various fisheries and regions, but there is no regular measurement of employment in this sector.

[18] Tour boats should more properly be counted under tourism and recreation, and some are. But the SIC system does not separate ferry services from tour boats if the establishment is classified as waterborne passenger transportation.

[19] Metro and nonmetro are based on the 1990 designation of counties. The distribution by the size of the Urban Influence Codes of the U.S. Department of Agriculture Economic Research Service. See http://www.ers.usda.gov/briefing/rurality/UrbanInf/.

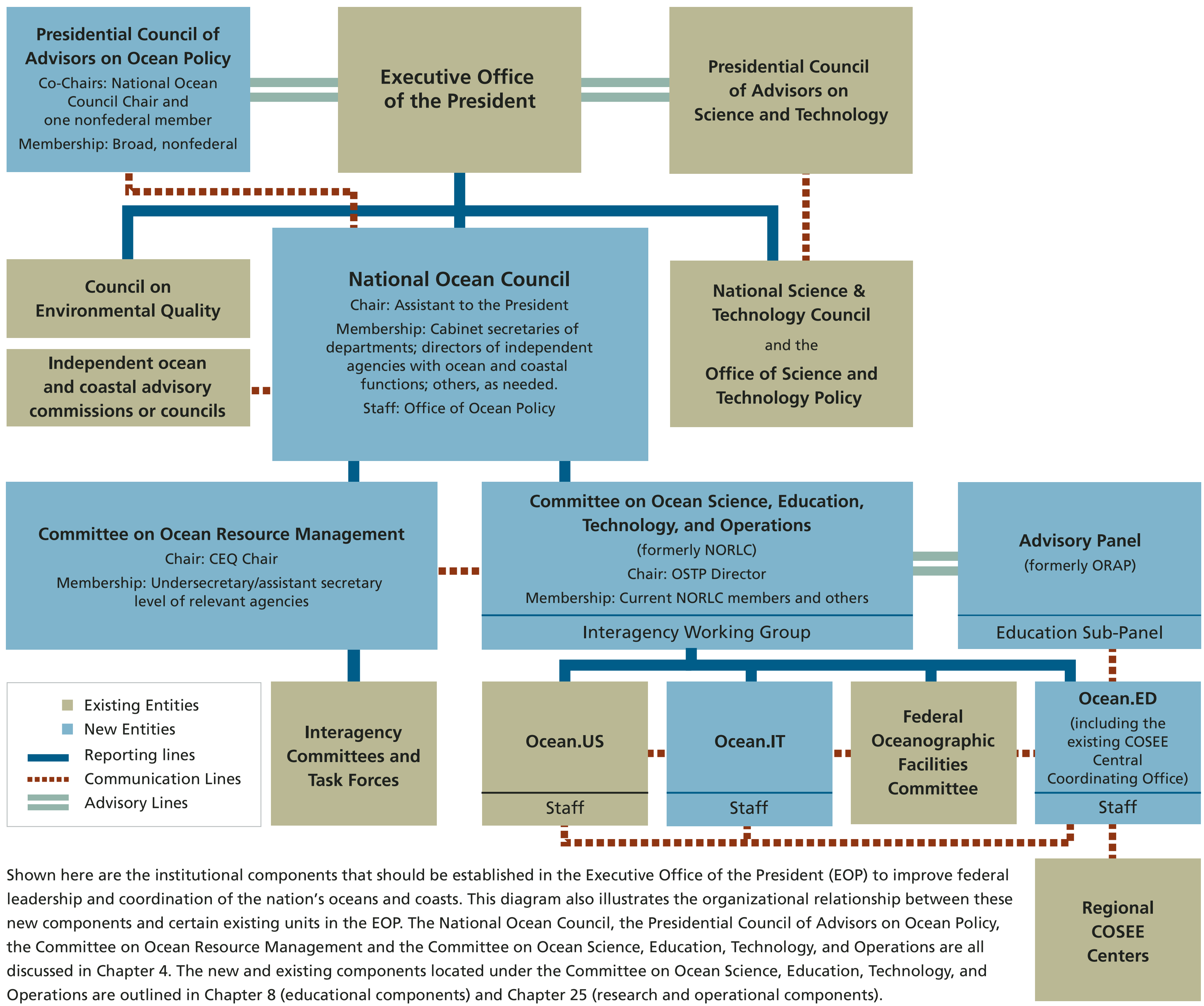
[20] A number of federal laws, including the Clean Water Act, the Comprehensive Environmental Response, Compensation, and Liability Act, and the National Marine Sanctuaries Act require that economic damages from events such as oil spills be assessed.

[21] The economic term is consumer surplus, the value represented by what one would be willing to pay to use a beach less what someone actually pays to use the beach.

APPENDIX D:
GUIDE TO OCEAN-RELATED LAWS, PROGRAMS, COUNCILS, COMMISSIONS, INTERNATIONAL TREATIES, AND INTER-GOVERNMENTAL BODIES

(To be completed for the Final Report; not yet available)

Proposed Structure for Coordination of Federal Ocean Activities



Shown here are the institutional components that should be established in the Executive Office of the President (EOP) to improve federal leadership and coordination of the nation's oceans and coasts. This diagram also illustrates the organizational relationship between these new components and certain existing units in the EOP. The National Ocean Council, the Presidential Council of Advisors on Ocean Policy, the Committee on Ocean Resource Management and the Committee on Ocean Science, Education, Technology, and Operations are all discussed in Chapter 4. The new and existing components located under the Committee on Ocean Science, Education, Technology, and Operations are outlined in Chapter 8 (educational components) and Chapter 25 (research and operational components).

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