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 diminished.

The nation needs a comprehensive national ocean policy, implemented through an integrated and coordinated management structure that results in 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 marine environment while creating jobs, increasing revenues, enhancing security, protecting cultural heritage, 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 resources that fuel industry and sustain our standard of living, and a diversity of biological species 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

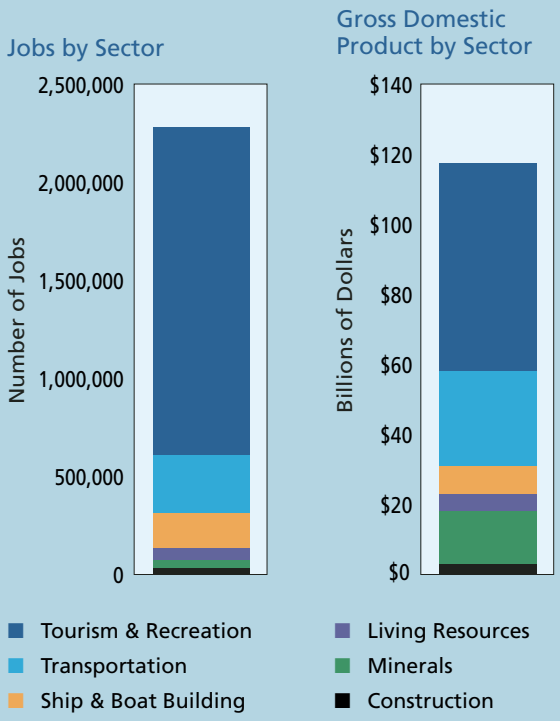
America's oceans and coasts are big business. The United States has jurisdiction over 3.4 million square nautical miles of ocean territory in its exclusive economic zone—larger

than the combined land area of all fifty states. Millions of families depend on paychecks earned directly or indirectly from the value of the sea, including the magnetic pull of the nation's coasts and beaches. 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, including 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 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



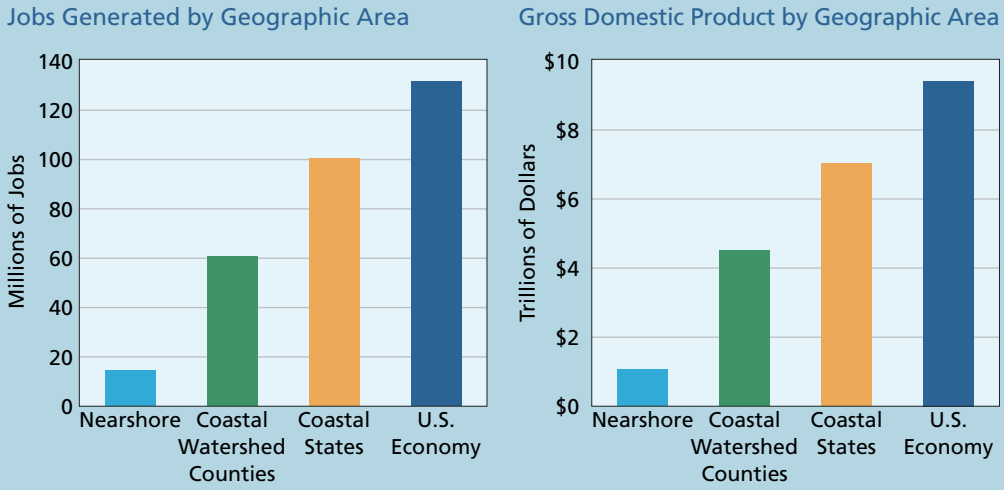
The ocean economy includes activities that rely directly on ocean attributes or that take place on or under the ocean. In 2000, Tourism and Recreation was the largest sector in the ocean economy, providing approximately 1.6 million jobs.

Source: Living Near… and Making a Living From… the Nation's Coasts and Oceans, Appendix C.

The level of overall economic activity within coastal areas 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 *nearshore* areas, 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 Box 1.1.) The contribution to employment is equally impressive, with sixteen million jobs in nearshore areas and sixty million in *coastal watershed counties*. (See Appendix C for additional details.)

Even these remarkable numbers do not fully capture the economic contributions of oceans and coastal 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 $12 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

Figure 1.2 The Value of the Coasts



Coastal watershed counties, which account for less than a quarter of U.S. land area, are significant contributors to the U.S. economy. In 2000, they were home to nearly half of the nation's jobs and generated a similar proportion of the nation's gross domestic product.

Source: Living Near… and Making a Living from… the Nation's Coasts and Oceans, Appendix C.

$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 ocean-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.

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.[10] 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 three 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.[11,12]

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.[13] 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 U.S. 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.[14]

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. As easily accessible sand resources are depleted, offshore areas along the Atlantic and Gulf coasts will be used increasingly to provide such resources to restore and protect coastal communities, beaches, and habitat. Minerals, such as phosphates, polymetallic 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 known species, with millions more yet to be discovered. An expedition to previously unexplored waters typically leads to the discovery of dozens of new species. 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 anti-cancer drugs. Blood drawn from the horseshoe crab is used to detect potentially harmful toxins in drugs, medical devices, and water. A synthetic drug

Box 1.1 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 nearshore (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 or territory 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, 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.[i]

The Nearshore

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

[i] National Oceanic and Atmospheric Administration. *Spatial Patterns of Socioeconomic Data from 1970 to 2000: A National Research Dataset Aggregated by Watershed and Political Boundaries.* Silver Spring, MD, 2001.

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.

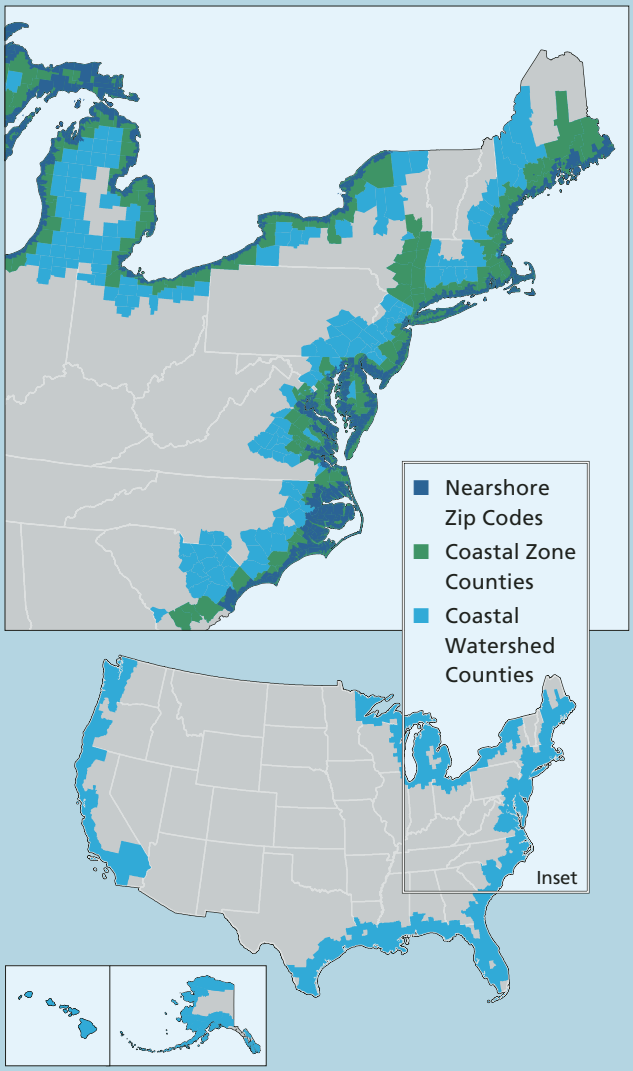
Remarkably, in this first decade of the 21st century, about 95 percent of the world's ocean area remains unexplored. We have barely begun to comprehend the full richness and value of the diverse resources residing beneath the surface of the sea.

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.

Figure 1.3 The Coasts: From the Nearshore to Coastal Watersheds



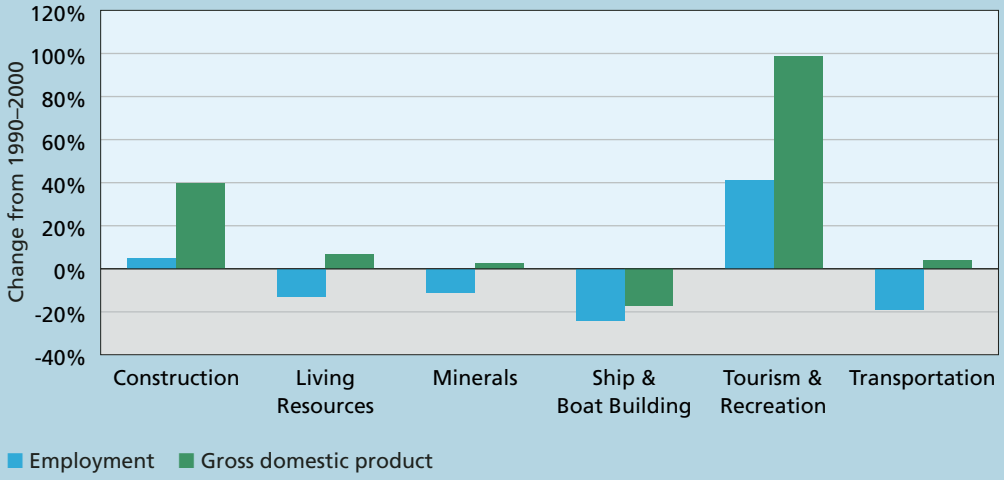
Varying interpretations of the geographic area encompassed by "the coast" have hampered our ability to quantify the economic and ecologic importance of this dynamic region. Defining distinct regions, including the nearshore, the coastal zone, and coastal watersheds, provides scientists and decision makers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

Source: Living Near… and Making a Living From… the Nation's Coasts and Oceans, Appendix C.

While there is no national program to calculate the economic value of the oceans and coasts, several recent studies highlight the contributions of beach-related activities to the economy. In southern California, visitors spent in excess of $1 billion at the beaches of Orange and Los Angeles Counties during the summer of 2000.[15] The annual value of Great Lakes beach visits may be as high as $1.65 billion.[16] And in Hawaii, coral reefs are a major source of recreational benefits, generating an estimated $360 million per year.[17]

The real value of ocean recreation, however, goes beyond the number of jobs created or amount of income produced—there are also immeasurable benefits to individuals and society in being able to enjoy a day at the beach or in the water.

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



Between 1990 and 2000, the ocean economy experienced a significant increase in the importance of service-oriented activities. This trend is clearly illustrated by the dramatic increase in both employment and output associated with tourism and recreation. Shifts in employment and revenue in the traditional goods-producing sectors—minerals, living resources, transportation, ship and boat building—were affected by changes in technology, national priorities, and the status of living and nonliving resources.

Source: Living Near… and Making a Living From… the Nation's Coasts and 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, listen to the waves crashing, and gaze upon the watery horizon at sunset. Coastal cities are major economic assets, supporting working ports and harbors and generating tourism. This has made areas close to the coast 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.[18] 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.[19]

Nonmarket Values

Many of the most valuable contributions of our oceans and coasts are not readily measured by traditional 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." In addition, the cultural importance of the ocean and its resources to indigenous populations living along the coasts and in island states and territories should not be underemphasized. 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 priorities for marine management and protection.

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,[20] 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.

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 and estuarine habitats.[21]

Tropical coral reefs cover only about one-fifth of 1 percent of ocean area and yet provide a 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.[22] 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 oceans' 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. Exposure to underwater historical resources provides teachers with a bridge to past cultures, offering unique opportunities to study history, sociology, and anthropology. 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

Many nations border on, or have direct access to, the sea. 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

Box 1.2 The "Fourth Seacoast"—The Great Lakes

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 reside within the basin.

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.

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. Coastal and ocean water quality is threatened by multiple sources of pollution, including point, nonpoint, and atmospheric sources, vessel pollution, and trash washed onto beaches and into the ocean. In 2001, 23 percent of the nation's estuarine areas were impaired for swimming, fishing, and supporting marine species.[23] 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.[24] 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.[25] 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.[26,27]

Other Contaminants

A 2003 National Research Council report estimated 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.[28]

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 2003, more than 18,000 days of beach closings and swimming advisories were issued across the nation, often directly related to bacteria associated with fecal contamination from stormwater and sewer overflows. This represents a 50 percent increase in closures and advisories from 2002, continuing a rising trend that can be attributed to improved monitoring and more thorough reporting, and revealing the true extent of beachwater pollution.[29] The consequences of such contamination cost many millions of dollars a year in decreased revenues from 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.[30] In the last two decades, reports of gastrointestinal and neurological diseases associated with algal blooms and waterborne bacteria and viruses have increased.[31] Though seafood poisonings are probably underreported, they also seem to be rising in incidence and geographic scope.[32]

Harmful algal blooms cost our nation an average of $49 million a year[33] 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 5 or more toxic contaminants at detectable levels. More than 600 sites had contamination levels high enough to harm fish and other aquatic organisms.[34] Because some

chemicals tend to bind to particles and thus accumulate in sediments, bottom-dwelling and bottom-feeding organisms are particularly 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 and productive marine resources.

Fishery Declines

Experts estimate that 25 to 30 percent of the world's major fish stocks are overexploited,[35] and a recent report indicates that U.S. fisheries are experiencing similar difficulties. Of the nation's 267 major fish stocks—representing 99 percent of all landings—roughly 20 percent are either already overfished, experiencing overfishing, or approaching an overfished condition.[36] The same report indicates that there is inadequate information to make these status determinations for over 30 percent of the major fish stocks and virtually all of the over 640 minor fish stocks—most of which are not subject to commercial fishing pressure—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 changes, and uneven management. The cumulative impact 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,"[37] thereby causing changes in the size, age structure, genetic makeup, and reproductive status of fish populations. This 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.[38,39] In the Northwest, decreasing salmon populations have cost 72,000 jobs and more than $500 million.[40] 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.[41] California has lost 91 percent of its wetlands since the 1780s.[42] And Louisiana, which currently is home to 40 percent of the coastal wetlands in the lower 48 states, is losing 25–35 square miles of wetlands each year.[43]

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.[44] 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.[45] 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.

Living and coastal resources are threatened by pollution and human activities. We've seen collapses of fisheries and overfishing of many stocks. We are losing 20,000 acres of coastal wetlands each year. We are losing millions of acres of coral reefs each year worldwide. Increasing coastal development presents new stresses and greater vulnerability to extremes of weather and changes in sea level.

—The Honorable James Connaughton, *Chairman, White House Council on Environmental Quality, testimony to the Commission, September 2001*

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 habitats of North America and that hundreds can be found in a single estuary.[46] 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.[47]

Many 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.[48,49] Further contributors to the spread of invasive species include the aquarium trade, fishery-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. More than $2 million has been spent in California to control and monitor the spread of the Mediterranean green seaweed *Caulerpa taxifolia*, and more than $3 million has been spent investigating the impacts of Atlantic cordgrass on the Pacific Coast.[50] Invasive species can also cause significant ecological damage by outcompeting native species, altering local food webs, and reducing the resources available for other organisms.

Conflicts Between Man and Nature

As population density has risen in coastal watersheds, so has environmental stress. Coastal planning and management policies 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.[51] 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).

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.[52] 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.[53] A one-acre parking lot produces sixteen times the volume of runoff that comes from a one-acre meadow.[54] 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.[55] 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.[56] Nearshore 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 nearshore areas accelerating at a rate far greater than might be expected based simply on population trends.

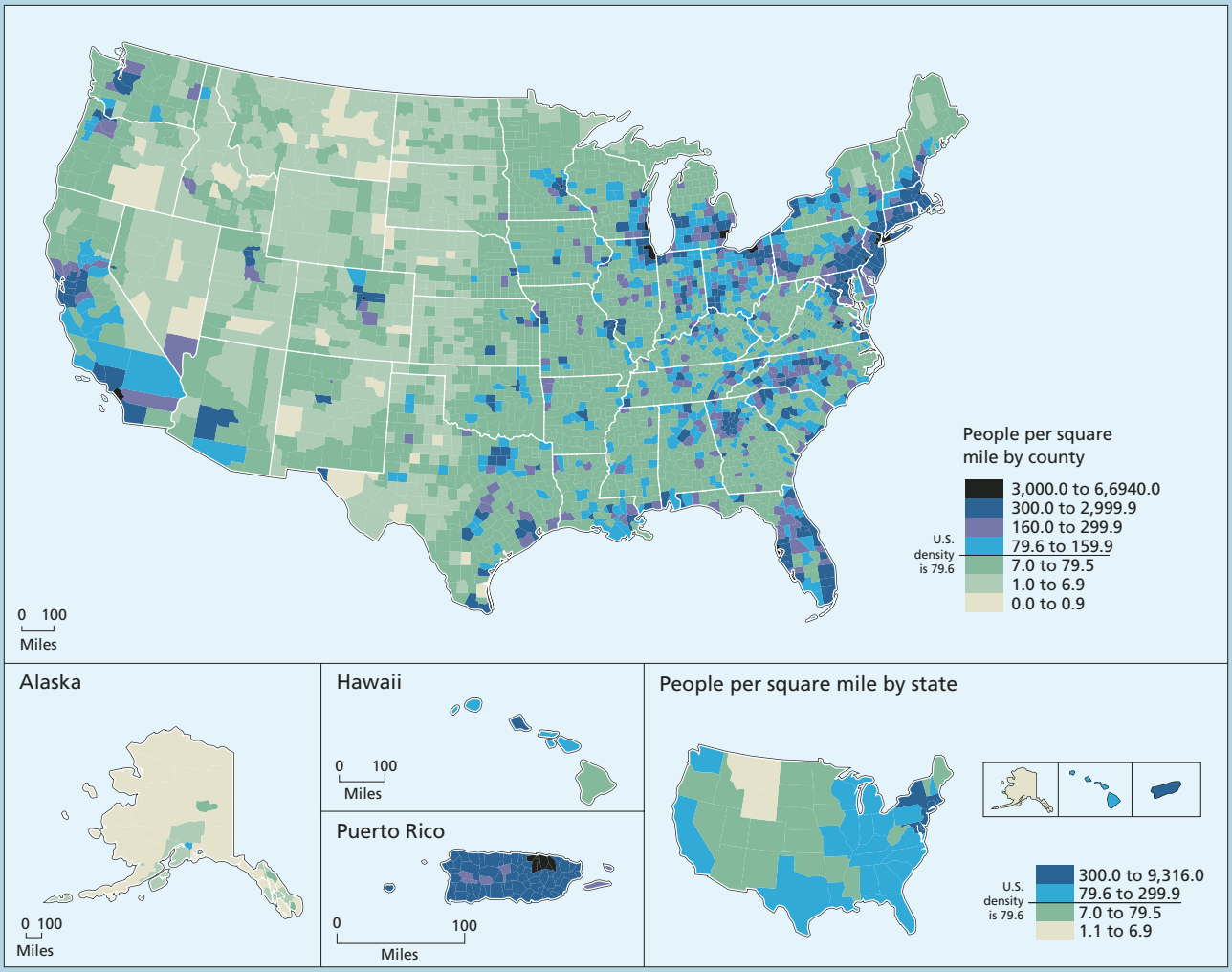
A less apparent, but still important contributor to developmental pressures is the increasing rate of overall economic growth that is occurring in nearshore areas. Although population and housing are moving upstream within coastal watersheds, economic growth has been occurring more rapidly—and more intensely—along the nearshore. 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.[57] 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).[58,59]

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.[60] 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.

Figure 1.5 Population Density Peaks Near the Shore



As shown by 2000 U.S. Census figures, population density is generally highest in coastal areas, including counties surrounding the Great Lakes. Population growth and increasing population density in coastal counties reflect the attraction of the coast but also result in increased environmental impacts on coastal ecosystems.

Source: U.S. Census Bureau. "Census 2000." <www.census.gov> (Accessed March 2004).

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.[61] 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.[62] As oceans warm, the global spread and incidence of human diseases, such as cholera and malaria, may also increase.[63,64] 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 nearshore fish populations.[65]

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.[66] Although the exact amount and rate of the increase are uncertain, the fact that the ocean will continue to expand is widely accepted. 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 corals and mangroves, and loss of agricultural sites and infrastructure. For example, 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 also 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 approximately 4.25 feet from the late 1950s to the late 1990s.[67] Alarming changes are occurring in Arctic permafrost, with potentially significant economic and ecological impacts.[68] 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.[69]

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.[70] 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.[71]

The specter of abrupt change, and a growing awareness of the impacts even gradual climate change can have on coastal development, ecosystems, and human health, call for a significant improvement in climate research, monitoring, assessment, and prediction capabilities. Understanding the role of the oceans in climate is an area in need of particular attention.

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 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's complex ecosystems and the many cultures whose heritage is directly tied to the sea. 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 even greater benefits. But to achieve this, 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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