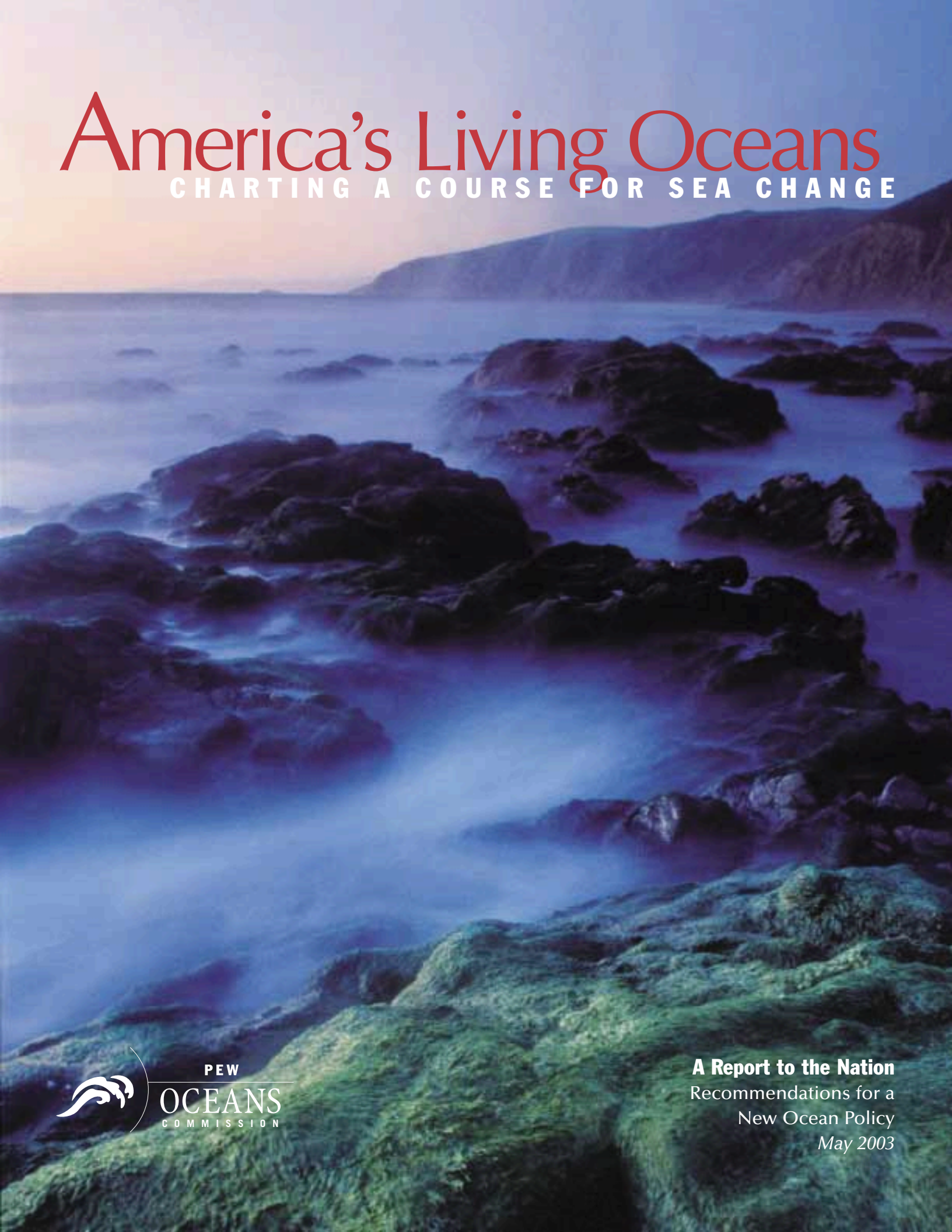
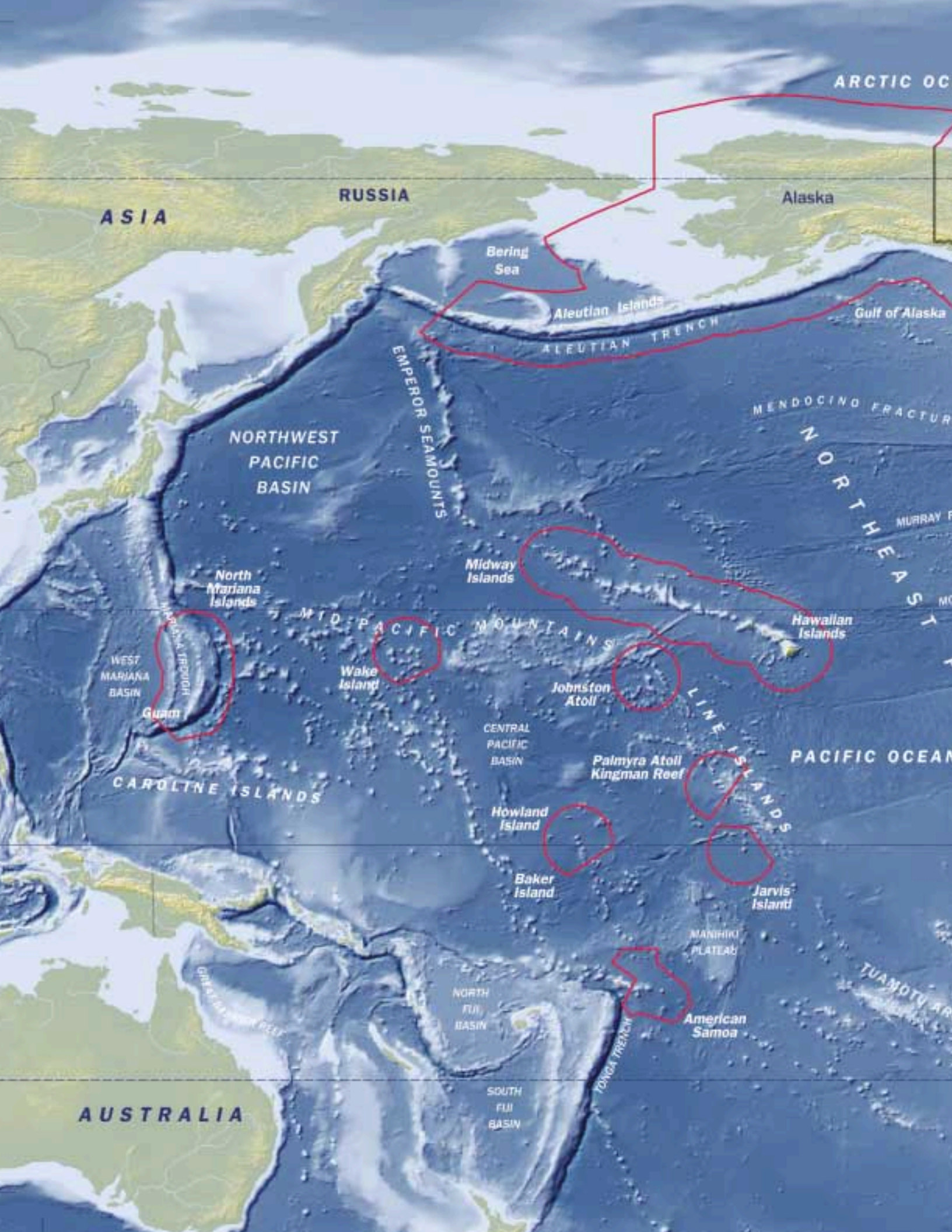
America's Living Oceans

CHARTING A COURSE FOR SEA CHANGE



PEW OCEANS COMMISSION

A Report to the Nation
Recommendations for a
New Ocean Policy
May 2003


ARCTIC OC
RUSSIA
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NORTHEAST
MURRAY F
North Mariana Islands
Midway Islands
MARIANA TROUGH
MID PACIFIC MOUNTAINS
Hawaiian Islands
WEST MARIANA BASIN
Wake Island
Johnston Atoll
Guam
CENTRAL PACIFIC BASIN
LINE ISLANDS
PACIFIC OCEAN
Palmyra Atoll
Kingman Reef
CAROLINE ISLANDS
Howland Island
Baker Island
Jarvis Island
MANIHIKI PLATEAU
NORTH FIJI BASIN
American Samoa
TONGA TRENCH
AUSTRALIA
SOUTH FIJI BASIN


AMERICA'S OCEAN REALM
ARCTIC CIRCLE
CANADA
NORTH AMERICA
UNITED STATES
MEXICO
Gulf of Mexico
CONTINENTAL SHELF
BLAKE PLATEAU
ATLANTIC OCEAN
TROPIC OF CANCER
Puerto Rico & U.S. Virgin Islands
Caribbean Sea
EQUATOR
SOUTH AMERICA
PERU BASIN
EAST PACIFIC RISE
SALA Y GÓMEZ RIDGE
TROPIC OF CAPRICORN
CLARION FRACTURE ZONE
CLIPPERTON FRACTURE ZONE
PACIFIC BASIN
Boundary of the United States Exclusive Economic Zone
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Front and Back Cover

Light of the setting sun bathes battered sea stacks shrouded by summer fog at McClure's Beach, in Point Reyes National Seashore, California. Here, pounding Pacific waves have carved a shoreline of white crescent beaches and rocky cliffs.

Foldout Map

The United States' oceans span nearly 4.5 million square miles, an area 23 percent larger than the land area of the nation.

David Sanger/davidsanger.com

America's Living Oceans

CHARTING A COURSE FOR SEA CHANGE

A Report to the Nation
Recommendations for a
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May 2003

PEW
OCEANS
COMMISSION

Leon E. Panetta, Chair

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Sea otter with starfish, Central California coast
Tom & Pat Leeson

Steve Simonsen/Marine Scenes

Cushion sea star, Hurricane Hole, U.S. Virgin Islands

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State of America's Oceans

© Chuck Davis/www.tidalflatsphoto.com

California garibaldi in a kelp forest, Santa Catalina Island, California

Steve Simonsen/Marine Scenes

Cushion sea stars, Virgin Islands National Park, U.S. Virgin Islands

PART TWO

A Public Good at Risk

PART THREE

Detailed Recommendations

Foreword

Oregon Dunes National Recreation Area, Florence, Oregon

At the heart of the American Dream is a desire to secure a better future for our children.

That is what my grandfather sought as he sailed the oceans in great sailing ships and fished off California and Alaska. That is what my immigrant parents worked for when they moved their family from Italy to central California. And, that is the commitment my wife and I have made for our children.

There can be no legacy without caring for those things most important to us. In our family, preserving the oceans' beauty and bounty for future generations is an obligation to be honored.

I grew up and live in Monterey, California—a community made famous by John Steinbeck's *Cannery Row*—where boundless catches of sardines, bustling canneries, large fishing fleets of purse seiners, and busy wharves and shops served and supported fishermen and their families. When the sardine industry collapsed, the lives and businesses that depended on that seemingly endless resource also collapsed.

My goal has been to end this kind of devastation, which threatens other fishing communities along our coasts. For 16 years, I represented coastal residents in Congress, fighting to protect the oceans and those whose livelihoods depend upon them. One of my proudest accomplishments is the creation of the Monterey Bay National Marine Sanctuary to restore, protect, and sustain the living resources so vital to the beauty and economy of this coast.

Nearly three years ago, my love for the oceans brought me to the Pew Oceans Commission. I am joined in this effort by a distinguished group of individuals, each with a special connection to the oceans. They bring many lifetimes of leadership and accomplishment from the worlds of science, fishing, conservation, government, education, business, and philanthropy. They are bipartisan and independent, hailing from the North Atlantic to the South Pacific.

Based on our careful review of the laws, policies, and institutions affecting life off our shores, we advocate a fundamental change in this nation's posture toward its oceans. The recommendations presented here reflect the testimony of hundreds of individuals who joined us in public hearings and other gatherings across the country. We also solicited the best thinking of leading scientists and the firsthand experiences of fishermen, conservationists, and businesspeople.

Jeff Sedlik/Workbookstock.com

The oceans are a national trust we must preserve for this and future generations.

There is consensus that our oceans are in crisis and that reforms are essential. In the 1960s, the Stratton Commission reviewed U.S. ocean policy, found it lacking, and the nation responded. Much has changed in the ensuing years, and once again a commitment is needed to protect and preserve this national trust.

A century ago, President Theodore Roosevelt committed the nation to the critical objective of preserving our land. Today, we have a similar responsibility to the seas that cover about 71 percent of our planet. These recommendations provide an opportunity and the means to meet our obligation and provide for our children a bountiful ocean legacy.

Leon E. Panetta
Chair, Pew Oceans Commission

Preface

DEEP WATER: AMERICA'S OCEANS IN TROUBLE

Digital Vision

Americans have always loved the ocean. Half of us live in coastal communities and the other half come to visit. Perhaps, as President John F. Kennedy once suggested, it is "the salt in our veins."

When we stand at the water's edge, we stare longingly out to sea—for the boat to return, for the tides to shift, for the winds to arrive, for the fish to bite, for the sun to rise or set—beyond the far horizon.

Inspired by their majesty and mystery, we depend on our oceans and their coasts, not just for pleasure and food—although these uses are central—but also as a counterweight to extremes of heat and cold on land, as a sponge for absorbing excess carbon, and as a generator of life-giving oxygen. Although we often view the ocean as starting where the land ends, that separation is arbitrary. Land and oceans are part of the same global system. Activities on one profoundly affect the other.

Just as the 20th century brought us into knowledgeable contact with outer space, the 21st will almost certainly connect us more intimately to our oceans. In fact, it is imperative because—as much as we love our oceans—our ignorance has been destroying them. We love clean beaches, but what we discharge into the oceans befouls them. We destroy the very coastal wetlands we need to buffer storms and filter fresh water. A nation of seafood lovers, we are careless about how we treat the ocean's "nurseries" and brood stocks that replenish our fish supply.

Furthermore, the size of the world's human population and the extent of our technological creativity have created enormously damaging impacts on all of the oceans. We are now capable of altering the ocean's chemistry, stripping it of fish and the many other organisms which comprise its amazingly rich biodiversity, exploding and bleaching away its coral nurseries, and even reprogramming the ocean's delicate background noise.

We love our freedom to move about the ocean surface where no streets, signs, or fences impede us, yet our sense that no one owns this vast realm has allowed us to tolerate no one caring for it.

During the 20th century our nation has come to regard the air we breathe, the fresh water we drink, and the open lands as "common goods," part of our public trust. Now we must acknowledge that the oceans, too, are part of our common heritage and our common responsibility.

The report of the Pew Oceans Commission outlines a national agenda for protecting and restoring our oceans. It is a vision that projects an equilibrium of goods withdrawn from and goods regenerated within the ocean. It is a vision that abhors the careless—no less the systematic—extinction of vital sea species. It is a vision of clean water and clear horizons. Both comprehensive and detailed, the report presents a new direction for governing our oceans. From identifying the nonpoint pollutants that rush down our waterways into our coastal bays to proposing protected zones for critical marine life, the Commission has confronted the most challenging aspects of ocean policy. If its recommendations are accepted and acted upon, we can anticipate a future when fish will again be plentiful and fishing communities will thrive, when beaches will be clean again, and now-impoverished coral reefs will teem with life.

We invite the American public to embrace this vision and to join with us to launch a national effort in behalf of future generations—to understand and protect our vast and bountiful, fragile and mysterious seas.

Steve Simonsen/Marine Scenes

Pacific double-saddle butterfly fish, Western Shoals, Agana Harbor, Guam

David Rockefeller, Jr.
Vice Chair, National Park Foundation
Member, Pew Oceans Commission

Members
OF THE PEW OCEANS COMMISSION

Kenai Fjords National Park, Alaska
Deb Antonini/Pew Oceans Commission

The Honorable Leon E. Panetta, Chair
He is director of the California State University Panetta Institute for Public Policy. He served in Congress for eight terms. He chaired the House Budget Committee and served as White House chief of staff.

John H. Adams
He is the founder and president of the Natural Resources Defense Council —one of the nation's leading environmental organizations. In 1998, he was named one of Audubon's 100 Champions of Conservation.

The Honorable Eileen Claussen
She is president of the Pew Center on Global Climate Change. She is a former assistant secretary of state for oceans, environment, and science.

The Honorable Carlotta Leon Guerrero
She is a former member of the Guam Senate where she chaired committees with jurisdiction over transportation, telecommunications, and Micronesian affairs. She is currently co-director of the Ayuda Foundation, a nonprofit health care organization in Guam.

The Honorable Mike Hayden
He is the secretary of the Kansas Department of Wildlife and Parks. The former governor of Kansas served as president and CEO of the American Sportfishing Association, a recreational fishing group.

Geoffrey Heal, Ph.D.
He is the Garrett Professor of Public Policy and Corporate Responsibility and professor of economics and finance at the Graduate School of Business at Columbia University. One of his major research interests is the interaction of human societies and their natural resources.

Charles F. Kennel, Ph.D.
He is director of the Scripps Institution for Oceanography and the author of more than 250 publications in plasma physics, planetary science, and astrophysics. He has been both a Fulbright and Guggenheim Scholar.

The Honorable Tony Knowles
He recently completed his second term as governor of Alaska. He was the mayor of Anchorage and served on the North Pacific Fishery Management Council, where he was instrumental in efforts to reduce bycatch.

Jane Lubchenco, Ph.D.
She is an Oregon State University professor of marine biology, a MacArthur Fellow, and past president of both the American Association for the Advancement of Science and the Ecological Society of America. She is president-elect of the International Council for Science, and recipient of the 2002 Heinz Award for the Environment.

Julie Packard
She is the founder and executive director of the Monterey Bay Aquarium and vice chair of the David and Lucile Packard Foundation. She is the 1998 recipient of the Audubon Medal for Conservation.

The Honorable Pietro Parravano
He is a commercial fisherman and owner of the *Anne B.* He is the president of the Pacific Coast Federation of Fishermen's Associations and an elected member of the San Mateo County Harbor Commission.

The Honorable George E. Pataki
He is currently serving his second term as governor of New York. After graduating from Columbia Law School, he served ten years in the state legislature and was mayor of the city of Peekskill, his hometown.

The Honorable Joseph P. Riley, Jr.
He is serving his seventh term as mayor of Charleston, South Carolina. He has served as the president of the U.S. Conference of Mayors and has received many awards, including the Outstanding Mayors Award from the National Urban Coalition.

David Rockefeller, Jr.
He is director and former chair of Rockefeller Co., Inc., and is an active participant in the nonprofit fields of art, philanthropy, and the environment. He is a vice chair of the National Park Foundation and trustee of the Rockefeller Brothers Fund.

Vice Admiral Roger T. Rufe, Jr., U.S. Coast Guard (Retired)
He is the president and CEO of The Ocean Conservancy. While in the U.S. Coast Guard, he led offices responsible for marine conservation in Alaska and the Southeast U.S.

Kathryn D. Sullivan, Ph.D.
She is the president and CEO of COSI, a hands-on science center in Columbus, Ohio. As a NASA astronaut, she was the first U.S. woman to walk in space. She served as NOAA's chief scientist from 1992 to 1996. She has a Ph.D. in geology.

Marilyn Ware
She is the chairman of the board of American Water Works Company, the nation's largest private drinking water utility. She is a former newspaper editor and publisher, and currently serves on the board of the American Enterprise Institute.

Patten (Pat) D. White
He is a commercial fisherman and CEO of the Maine Lobstermen's Association. He is a member of the Atlantic States Marine Fisheries Commission, and serves on the editorial board of *National Fisherman.*

Executive Summary

Bocaccio, Channel Islands National Marine Sanctuary, California
Richard Herrmann

America's oceans are in crisis and the stakes could not be higher. More than half the U.S. population lives in coastal counties. The resident population in this area is expected to increase by 25 million people by 2015. More than 180 million people visit the shore for recreation every year.

Though a price tag has never been assigned to our coastal economy, it is clear that it contributes significantly to the nation's overall economic activity. Tens of thousands of jobs in fishing, recreation, and tourism depend on healthy, functioning coastal ecosystems. Now, thousands of jobs and billions of dollars of investment have either been lost or are jeopardized by collapsing fisheries. Pollution and sprawl threaten ocean-related tourism and recreation, far and away the largest component of the coastal economy.

Ron Niebrugge/wildnatureimages.com

Fishing figures prominently in the economies of many coastal communities, including Seward, Alaska, where anglers fish for salmon in Resurrection Bay.

But more than jobs are at stake. All Americans depend on the oceans and affect the oceans, regardless of where they live. Ocean currents circulate the energy and water that regulate the Earth's climate and weather and, thus, affect every aspect of the human experience. Our very dependence on and use of ocean resources are exposing limits in natural systems once viewed as too vast and inexhaustible to be harmed by human activity. Without reform, our daily actions will increasingly jeopardize a valuable natural resource and an invaluable aspect of our national heritage.

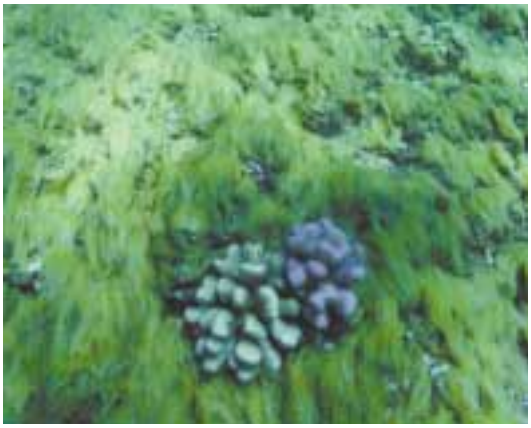
In the midst of crisis, there are expressions of hope and signs of success. Striped bass, severely depleted along our Atlantic shores, made a striking comeback when given a chance. North Atlantic swordfish recently did the same in response to lower catch limits and closed nursery areas. Seabirds, kelp beds, and fish communities returned to the coastal waters off Los Angeles after waste discharges were reduced. Proven, workable solutions to the crisis in our oceans exist but such successes will remain the exception rather than the rule until we chart a new course for ocean management.

THE EVIDENCE

The evidence that our oceans face a greater array of problems than ever before in our nation's history surrounds us. Marine life and vital coastal habitats are straining under the increasing pressure of our use. We have reached a crossroads where the cumulative effect of what we take from, and put into, the ocean substantially reduces the ability of marine ecosystems to produce the economic and ecological goods and services that we desire and need. What we once considered inexhaustible and resilient is, in fact, finite and fragile.

The crisis confronting our oceans has many dimensions.

- Coastal development and associated sprawl destroy and endanger coastal wetlands and estuaries that serve as nurseries for many valuable fishery species. More than 20,000 acres of these sensitive habitats disappear each year. Paved surfaces have created expressways for oil, grease, and toxic pollutants into coastal waters. Every eight months, nearly 11 million gallons of oil run off our streets and driveways into our waters—the equivalent of the *Exxon Valdez* oil spill.
- More than 60 percent of our coastal rivers and bays are moderately to severely degraded by nutrient runoff. This runoff creates harmful algal blooms and leads to the degradation or loss of seagrass and kelp beds as well as coral reefs that are important spawning and nursery grounds for fish. Each summer, nutrient pollution creates a dead zone the size of Massachusetts in the Gulf of Mexico. These types of problems occur in almost every coastal state* and the trends are not favorable. If current practices continue, nitrogen inputs to U.S. coastal waters in 2030 may be as much as 30 percent higher than at present and more than twice what they were in 1960.
- Many ecologically and commercially crucial fish species, including groundfish and salmon populations along the Atlantic and Pacific Coasts, face overfishing and numerous other threats. Thirty percent of the fish populations that have been assessed are overfished or are being fished unsustainably. An increasing number of these species are being driven toward extinction. Already depleted sea turtle, marine mammal, seabird, and noncommercial fish populations are endangered by incidental capture in fishing gear. Destructive fishing practices are damaging vital habitat upon which fish and other living resources depend. Combined, these aspects of fishing are changing relationships among species in food webs and altering the functioning of marine ecosystems.
- Invasive species are establishing themselves in our coastal waters, often crowding out native species and altering habitat and food webs. More than 175 introduced species thrive in San Francisco Bay alone. Nearly one million Atlantic salmon escaped from farm pens on the western coast of North America in the last 15 years. The species is now successfully



Nutrient pollution of coastal waters causes excessive algae growth on coral reefs, such as this one off Hawaii. Other major threats to reefs include climate change, overfishing, and sediment runoff resulting from development and agriculture.

*As used in this report, the terms "state" or "states" mean any or all of the fifty states, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, American Samoa, the Virgin Islands, Guam, and any other commonwealth, territory, or possession of the United States.

reproducing in British Columbia rivers and diluting the gene pool of native species by hybridizing with Pacific salmon. New species are regularly finding a home around our coastlines as hitchhikers in ship ballast water or on ship hulls, escapees from fish farms, and even as discarded home aquarium plants and animals. Of the 374 documented invasive species in U.S. waters, 150 have arrived since 1970.

In addition to these varied threats, climate change over the next century is projected to profoundly impact coastal and marine ecosystems. Sea-level rise will gradually inundate highly productive coastal wetlands, estuaries, and mangrove forests. Coral reefs that harbor exceptional biodiversity will likely experience increased bleaching due to higher water temperatures. Changes in ocean and atmospheric circulation attributable to climate change could adversely affect coastal upwelling and productivity and have significant local, regional, and global implications on the distribution and abundance of living marine resources.

These are just some of the signs that our interactions with the oceans are unsustainable. Our activities, from those that release pollutants into rivers and bays to the overfishing of the seas, are altering and threatening the structure and functioning of marine ecosystems—from which all marine life springs and upon which all living things, including humans, depend.

SEEDS OF CRISIS

The root cause of this crisis is a failure of both perspective and governance. We have failed to conceive of the oceans as our largest public domain, to be managed holistically for the greater public good in perpetuity. Our oceans span nearly 4.5 million square miles,* an area 23 percent larger than the nation's land area. Similarly, we have only begun to recognize how vital our oceans and coasts are to our economy as well as to the cultural heritage of our nation. Finally, we have come too slowly to recognize the interdependence of land and sea and how easily activities far inland can disrupt the many benefits provided by coastal ecosystems.

The foundation of U.S. ocean policy was laid in a very different context than exists today. The principal laws to protect our coastal zones, endangered marine mammals, ocean waters, and fisheries were enacted 30 years ago, on a crisis-by-crisis, sector-by-sector basis. Much of what exists of an ocean governance system in this country can be traced to recommendations of the Stratton Commission—the nation's first review of ocean policy in 1969. Driven by the need to ensure the "full and wise use of the marine environment," Stratton focused on oceans as a frontier with vast resources, and largely rec-

*This is the approximate area (in square statute miles) of the United States Exclusive Economic Zone (EEZ)—the area of the oceans over which the United States exercises exclusive environmental and economic jurisdiction. The U.S. EEZ was established by Presidential Proclamation in 1983. The establishment of an EEZ extending 200 nautical miles from the shoreline of a coastal nation is recognized and accepted under the United Nations Convention on the Law of the Sea.

Deb Antonini/Pew Oceans Commission

Commissioners tour a cannery in Kodiak, Alaska, home port for more than 700 trawl, longline, and crab vessels.

ommended policies to coordinate the development of ocean resources.

Reflecting the understanding and values of this earlier era, we have continued to approach our oceans with a frontier mentality. The result is a hodgepodge of ocean laws and programs that do not provide unified, clearly stated goals and measurable objectives. Authority over marine resources is fragmented geographically and institutionally. Principles of ecosystem health and integrity, sustainability, and precaution have been lost in the fray. Furthermore, the nation has substantially underinvested in understanding and managing our oceans. The information we do have in hand is often underutilized. Plagued with systemic problems, U.S. ocean governance is in disarray.

A 30-YEAR REVIEW OF OCEAN POLICY

More than 30 years after the Stratton Commission issued its recommendations, the state of our oceans and coasts is vastly altered. Although some of the problems that were considered 30 years ago remain with us today, new environmental, economic, and policy challenges have emerged. These challenges exceed the capacity of today's governance framework and management regimes.

Our perspective on ocean resources and policy has also changed over 30 years. We are increasingly aware that development activities can change marine environments. We are learning more about complex interactions in marine ecosystems and the need to maintain the diversity and resilience of those complex and adaptive natural systems. Today, there is a

clear sense that we must do a better job of protecting the oceans if we hope to continue to enjoy their benefits.

The Pew Oceans Commission, a bipartisan, independent group of American leaders, was created to chart a new course for the nation's ocean policy. Our mission is to identify policies and practices necessary to restore and protect living marine resources in U.S. waters and the ocean and coastal habitats on which they depend. The Commission was also charged with raising public awareness of the principal threats to marine biodiversity and of the importance of ocean and coastal resources to the U.S. economy.

Chris Mann/Pew Oceans Commission

Senator Ernest Hollings (D-SC) welcomes Leon Panetta, Dana Beach of the South Carolina Coastal Conservation League, and Deb Antonini of the Pew Oceans Commission at the release of Mr. Beach's report on coastal sprawl.

The Commission brought together a diverse group of American leaders from the worlds of science, fishing, conservation, government, education, business, and philanthropy. It secured the help of leading scientists to determine priority issues and to write reports summarizing the best scientific information available on those subjects (see list of publications on page 136). The Commission organized into four committees to review the core issues of governance, fishing, pollution, and coastal development. It also investigated marine aquaculture, invasive species, ocean zoning, climate change, science, and education.

For more than two years, the Commission conducted a national dialogue on ocean issues. We convened a series of 15 regional meetings, public hearings, and workshops to listen to those who live and work along the coasts. From Maine to Hawaii, Alaska to the Gulf of Mexico, we spoke with hundreds of citizens, fishermen, scientists, government officials, tourism operators, and business leaders. Commissioners held a series of 12 focus groups with fishermen, including one in Kodiak, Alaska, which is among the nation's oldest and largest fishing communities. Believing that experience is the best teacher, Commissioners went lobster fishing in Maine, toured a pineapple plantation in Hawaii to learn about ways to control polluted runoff, and visited coastal habitat restoration projects in New York and South Carolina.

By speaking with those who live and work along the coasts and around the country, and by collecting the best scientific information available, the Commission learned a great deal about the problems facing our oceans, the consequences to coastal communities and the nation if we fail to act, and actions needed to overcome the crisis facing our oceans. The status quo is unacceptable. Future generations will judge this generation on whether it shoulders its responsibility.

CONCLUSIONS AND RECOMMENDATIONS

The fundamental conclusion of the Pew Oceans Commission is that this nation needs to ensure healthy, productive, and resilient marine ecosystems for present and future generations. In the long term, economic sustain-

ability depends on ecological sustainability.

To achieve and maintain healthy ecosystems requires that we change our perspective and extend an ethic of stewardship and responsibility toward the oceans. Most importantly, we must treat our oceans as a public trust. The oceans are a vast public domain that is vitally important to our environmental and economic security as a nation. The public has entrusted the government with the stewardship of our oceans, and the government should exercise its authority with a broad sense of responsibility toward all citizens and their long-term interests.

These changes in our perspective must be reflected in a reformed U.S. ocean policy. National ocean policy and governance must be realigned to reflect and apply principles of ecosystem health and integrity, sustainability, and precaution. We must redefine our relationship with the ocean to reflect an understanding of the land-sea connection and organize institutions and forums capable of managing on an ecosystem basis. These forums must be accessible, inclusive, and accountable. Decisions should be founded upon the best available science and flow from processes that are equitable, transparent, and collaborative.

To embrace these reforms and achieve our goal, the nation must realize five priority objectives:

1. Declare a principled, unified national ocean policy based on protecting ecosystem health and requiring sustainable use of ocean resources.
2. Encourage comprehensive and coordinated governance of ocean resources and uses at scales appropriate to the problems to be solved.
   a. The regional scale of large marine ecosystems is most appropriate for fisheries management and for governance generally.
   b. Coastal development and pollution control is most appropriately addressed at the watershed level.
3. Restructure fishery management institutions and reorient fisheries policy to protect and sustain the ecosystems on which our fisheries depend.
4. Protect important habitat and manage coastal development to minimize habitat damage and water quality impairment.
5. Control sources of pollution, particularly nutrients, that are harming marine ecosystems.

The Commission recommends the following actions to achieve these objectives.

Governance for Sustainable Seas

1. Enact a National Ocean Policy Act to protect, maintain, and restore the health, integrity, resilience, and productivity of our oceans.
2. Establish regional ocean ecosystem councils to develop and implement enforceable regional ocean governance plans.
3. Establish a national system of fully protected marine reserves.
4. Establish an independent national oceans agency.

5. Establish a permanent federal interagency oceans council.

Restoring America's Fisheries

1. Redefine the principal objective of American marine fishery policy to protect marine ecosystems.
2. Separate conservation and allocation decisions.
3. Implement ecosystem-based planning and marine zoning.
4. Regulate the use of fishing gear that is destructive to marine habitats.
5. Require bycatch monitoring and management plans as a condition of fishing.
6. Require comprehensive access and allocation planning as a condition of fishing.
7. Establish a permanent fishery conservation and management trust fund.

Preserving Our Coasts

1. Develop an action plan to address nonpoint source pollution and protect water quality on a watershed basis.
2. Identify and protect from development habitat critical for the functioning of coastal ecosystems.
3. Institute effective mechanisms at all levels of government to manage development and minimize its impact on coastal ecosystems.
4. Redirect government programs and subsidies away from harmful coastal development and toward beneficial activities, including restoration.

Cleaning Coastal Waters

1. Revise, strengthen, and expand pollution laws to focus on nonpoint source pollution.
2. Address unabated point sources of pollution, such as concentrated animal feeding operations and cruise ships.
3. Create a flexible framework to address emerging and nontraditional sources of pollution, such as invasive species and noise.
4. Strengthen control over toxic pollution.

Guiding Sustainable Marine Aquaculture

1. Implement a new national marine aquaculture policy based on sound conservation principles and standards.
2. Set a standard, and provide international leadership, for ecologically sound marine aquaculture practices.

Science, Education, and Funding

1. Develop and implement a comprehensive national ocean research and monitoring strategy.
2. Double funding for basic ocean science and research.
3. Improve the use of existing scientific information by creating a mechanism or institution that regularly provides independent scientific oversight of ocean and coastal management.
4. Broaden ocean education and awareness through a commitment to teach and learn about our oceans, at all levels of society.

This nation must decide how it will choose to meet the crisis in our oceans. Fundamentally, this is not a decision about us. It is about our children, and actions we must take to bequeath them thriving oceans and healthy coastlines.

This is our challenge. To meet this challenge, the nation must substantially increase its investment in understanding and managing its oceans. We need a much greater financial commitment to strengthen governance and management infrastructure, to improve our scientific understanding of marine ecosystems and human impacts, and to educate all Americans about the oceans.

If properly executed, this investment will be paid back manyfold in the form of abundant living ocean resources for centuries ahead. Without this investment, we risk further decline in ocean ecosystem health and serious consequences for human well-being far into the future.

Justin Kenney/Pew Oceans Commission

Commissioner Carlotta Leon Guerrero (above) joined Hawaiian schoolchildren for a taping of KidScience, *produced jointly by the Hawaii Department of Education and Hawaii Public Television, during the Commission's visit to Hawaii in February 2001.*

Part One

STATE OF AMERICA'S OCEANS

Cushion sea star, Hurricane Hole, U.S. Virgin Islands
Steve Simonsen/Marine Scenes

Introduction
THE OCEAN DOMAIN

Green sea turtle, Kona, Hawaii

Who has the most hope in the world? It is a fisherman, of course, for every time he casts out his line he has hope. Perhaps that hope can motivate us so that we can save and preserve the oceans and all its creatures from man, the apex predator.

Steven Sloan
Trustee, International Game Fish Association

The oceans are our largest public domain. America's oceans span nearly 4.5 million square miles, an area 23 percent larger than the nation's land area (Figure One). Their biological riches surpass those of our national forests and wilderness areas. The genetic, species, habitat, and ecosystem diversity of the oceans is believed to exceed that of any other Earth system. Yet, incredibly, we are squandering this bounty.

Humanity's numbers and the technological capacity of our age result in unprecedented impact upon the oceans and coasts (Box One, pages 4–5). The disturbing signs of these impacts can be found nearly everywhere we look.

Most obviously we are depleting the oceans of fish, and have been for decades. The government can only assure us that 22 percent of managed fish stocks are being fished sustainably. The decline of New England fisheries is most notorious. By 1989, New England cod, haddock, and yellowtail flounder had reached historic lows.

In U.S. waters, Atlantic halibut are commercially extinct—too rare to justify a directed fishing effort. In addition, by the mid-1990s, we halved the breeding population of Atlantic swordfish (Safina, 1994). However, such problems are by no means limited to the East Coast. In September 2002, the government imposed substantial restrictions on bottom fishing along the West Coast in an attempt to save four of the most depleted rockfish species. Populations of bocaccio rockfish, commonly sold as Pacific red snapper, have been driven to less than 10 percent of their historic numbers (MacCall and He, 2002).

One can find stories about the effects of development, pollution, and overfishing all along our coastal waters—from Alaska to the Gulf of Mexico to Hawaii's coral reefs. Often the tale begins far inland.

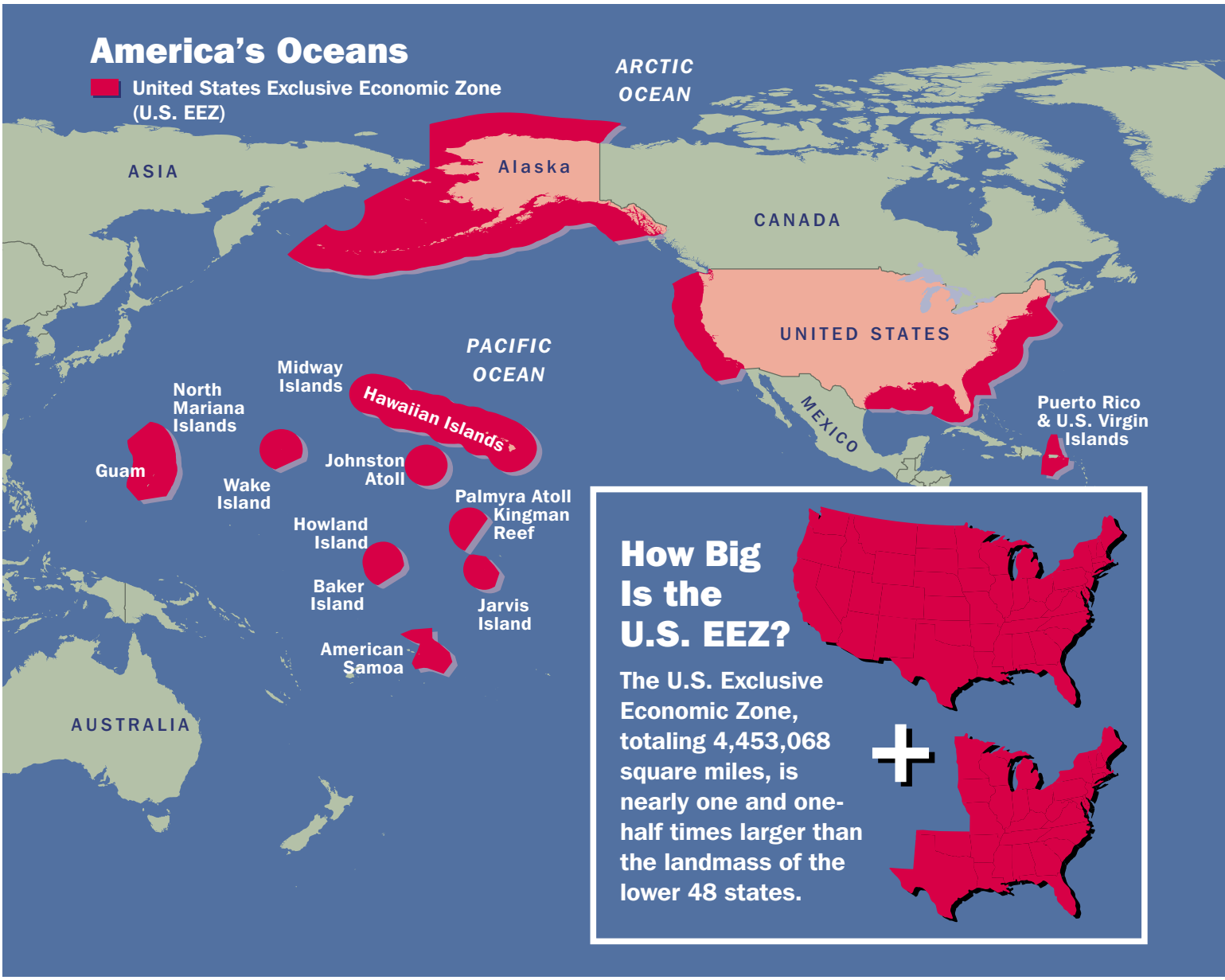
The greatest pollution threat to coastal marine life today is the runoff of excess nitrogen from fertilized farm fields, animal feedlots, and urban areas. Airborne nitrogen—from industrial smokestacks, automobile exhaust pipes, and ammonia rising from huge manure lagoons—is also deposited in the ocean.

Just as they fertilize the land, nutrients fertilize coastal waters, and excess amounts can cause massive blooms of algae. These blooms can trigger a chain of events that deplete the ocean waters of oxygen, turning vast areas into hypoxic areas, also known as dead zones. Some of these algal blooms produce toxins that can be fatal to fish, marine mammals, and occasionally people.

The deaths of one million menhaden in North Carolina's Pamlico Sound in 1991, 150 endangered Florida manatees in 1996, and 400 California sea lions along the central California coast in 1998 (Continued on page 6)

FIG. ONE

In 1983, President Ronald Reagan established the United States Exclusive Economic Zone, which extends 200 nautical miles* from our shores. In doing so, he created an "underwater continent" larger than our land area, encompassing nearly 4.5 million square miles.



*A nautical mile equals 1.15 statute miles.

Lucidity Information Design, LLC

Major Threats to Our Oceans

NONPOINT SOURCE POLLUTION

■ A recent National Academy of Sciences study estimates that the oil running off our streets and driveways and ultimately flowing into the oceans is equal to an *Exxon Valdez* oil spill—10.9 million gallons—every eight months (NRC, 2002a).

■ The amount of nitrogen released into coastal waters along the Atlantic seaboard and the Gulf of Mexico from anthropogenic sources has increased about fivefold since the preindustrial era, and may increase another 30 percent by 2030 if current practices continue (Howarth et al., 2000).

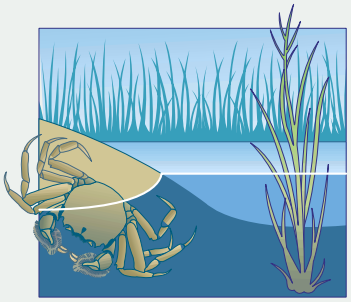
■ Two-thirds of our estuaries and bays are either moderately or severely degraded by eutrophication (Bricker et al., 1999).

■ More than 13,000 beaches were closed or under pollution advisories in 2001, an increase of 20 percent from the previous year (NRDC, 2002).

POINT SOURCE POLLUTION

■ In the U.S., animal feedlots produce about 500 million tons of manure each year, more than three times the amount of sanitary waste produced by the human population (EPA, 2002).

■ Based on EPA estimates, in one week a 3000-passenger cruise ship generates about 210,000 gallons of sewage, 1,000,000 gallons of gray water (shower, sink, and dishwashing water), 37,000 gallons of oily bilge water, more than 8 tons of solid waste, millions of gallons of ballast water containing potential invasive species, and toxic wastes from dry cleaning and photo-processing laboratories (Royal Caribbean Cruises Ltd., 1998; Eley, 2000; Holland America, 2002).



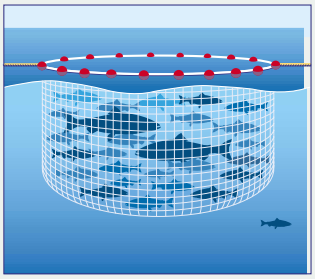
INVASIVE SPECIES

■ Introduced species crowd out native species, alter habitats, and impose economic burdens on coastal communities.

■ The rate of marine introductions has risen exponentially over the past 200 years and shows no sign of leveling off (Carlton, 2001).

■ More than 175 species of introduced marine invertebrates, fish, algae, and higher plants live in San Francisco Bay (Cohen and Carlton, 1995, 1998; Cohen and Carlton, unpublished data).

AQUACULTURE

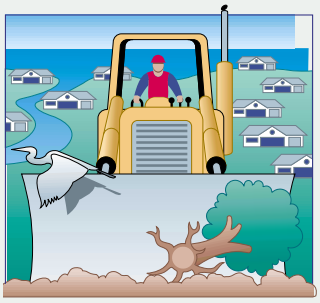


■ A December 2000 storm resulted in the escape of 100,000 salmon from a single farm in Maine, about 1,000 times the number of documented wild adult salmon in Maine (NRC, 2002b).

■ A salmon farm of 200,000 fish releases an amount of nitrogen, phosphorus, and fecal matter roughly equivalent to the nutrient waste in the untreated sewage from 20,000, 25,000, and 65,000 people, respectively (Hardy, 2000).

■ Over the past decade, nearly one million non-native Atlantic salmon have escaped from fish farms and established themselves in streams in the Pacific Northwest.

Art: John Michael Yanson



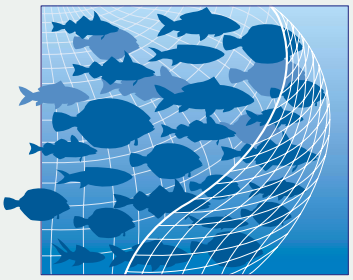
COASTAL DEVELOPMENT

■ Sprawl development is consuming land at a rate of five or more times the rate of population growth in many coastal areas. Sprawl needlessly destroys wildlife habitat and degrades water quality.

■ More than one-fourth of all the land converted from rural to suburban and urban uses since European settlement occurred during the 15-year period between 1982 and 1997 (the last year for which such figures are available) (NRI, 2000).

■ Coastal marshes, which trap floodwaters, filter out pollutants, and serve as "nurseries" for wildlife, are disappearing at a rate of 20,000 acres per year. Louisiana alone has lost half a million acres of wetlands since the 1950s.

OVERFISHING

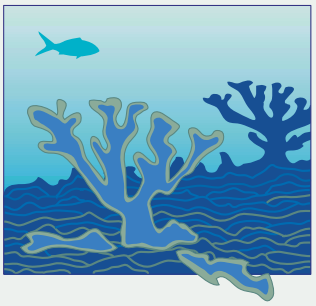


■ As of 2001, the government could only assure us that 22 percent of fish stocks under federal management (211 of 959 stocks) were being fished sustainably (NMFS, 2002).

■ Overfishing often removes top predators and can result in dramatic changes in the structure and diversity of marine ecosystems (Dayton et al., 2002).

■ By 1989, populations of New England cod, haddock, and yellowtail flounder had reached historic lows. In U.S. waters, Atlantic halibut are commercially extinct—too rare to justify a directed fishing effort. Populations of some rockfish species on the West Coast have dropped to less than 10 percent of their past levels (MacCall and He, 2002).

■ Rebuilding U.S. fisheries has the potential to restore and create tens of thousands of family wage jobs and add at least 1.3 billion dollars to the U.S. economy (POC, 2003).



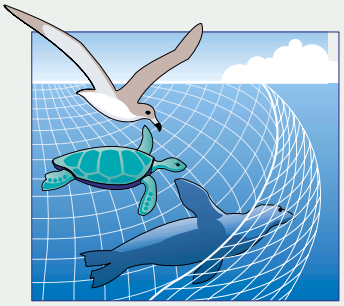
HABITAT ALTERATION

■ Fishing gear that drags along or digs into the seafloor destroys habitat needed by marine wildlife, including commercially fished species.

■ Typical trawl fisheries in northern California and New England trawl the same section of sea bottom more than once per year on average (Friedlander et al., 1999; Auster et al., 1996).

■ Bottom-dwelling invertebrates can take up to five years or more to recover from one pass of a dredge (Peterson and Estes, 2001).

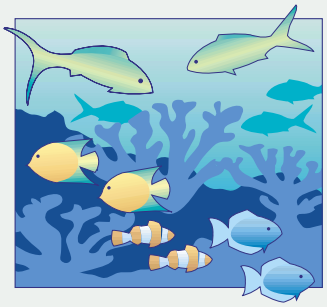
BYCATCH



■ Worldwide, scientists estimate that fishermen discarded about 25 percent of what they caught during the 1980s and the early 1990s, about 60 billion pounds each year (Alverson et al., 1994; Alverson, 1998).

■ Bycatch of albatrosses, petrels, and shearwaters in longline fisheries is one of the greatest threats to seabirds (Robertson and Gales, 1998; Tasker et al., 2000).

■ Bycatch in the Atlantic pelagic longline fishery may be jeopardizing the continued existence of the loggerhead and leatherback sea turtles off the eastern U.S. seaboard (NMFS, 2001).



CLIMATE CHANGE

■ Global air temperature is expected to warm by 2.5 to 10.4°F (1.4 to 5.8°C) in the 21st century, affecting sea-surface temperatures and raising the global sea level by 4 to 35 inches (9 to 88 cm) (IPCC, 2001).

■ Recent estimates suggest an increase in mean sea-surface temperature of only 2°F (1°C) could cause the global destruction of coral reef ecosystems (Hoegh-Guldberg, 1999).

■ Climate change will modify the flow of energy and cycling of materials within ecosystems—in some cases, altering their ability to provide the ecosystem services we depend upon.

■ Increases in temperature may slow or shut down the Atlantic thermohaline circulation that powers the Gulf Stream, causing reductions in sea-surface and air temperatures over the North Atlantic and northern Europe, changes in the geographic distributions of fisheries, and increased risk of hypoxia in the deep ocean.

have all been attributed to harmful algal blooms (McKay and Mulvaney, 2001). They disrupt aquaculture, wild fisheries, and coastal tourism. In the past two decades, their effects have expanded from a few scattered coastal areas to nearly all coastal states (Burke et al., 2000). But they are only one of the many human-related impacts that are transforming our coasts.

Coastal counties are now home to more than half of the U.S. population. Another 25 million people will live along the coast by 2015 (Beach, 2002), further straining our wetlands, mangrove forests, estuaries, coral reefs, and other coastal habitats.

Florida has experienced some of the nation's most rapid coastal development. From 1940 to 1996, the state population increased 700 percent, from 1.8 million to 14.3 million.

Development has altered both water quality and water quantity, leading to the loss of more than half of the Everglades, the largest contiguous wetland in the U.S. Freshwater flow through the Everglades has declined by approximately 70 percent since the 1940s and the population of wading birds has dropped by 90 percent (Koehler and Blair, 2001).

Much of Florida's development has been concentrated in 16 southern counties that extend from Lake Okeechobee to the Florida Keys. The marine ecosystems of the Keys are now undergoing rapid and profound changes.

Scientists recently conducted extensive surveys at 160 monitoring stations throughout the Florida Keys. They found that both the number of diseased areas of coral and of the number of diseased coral species had increased dramatically from 1996 to 1998. About 75 percent of the coral species in the Florida Keys show symptoms of a variety of diseases. In addition, two-thirds of the monitoring stations lost species between 1996 and 2000, and the total stony coral cover had decreased by about 40 percent between 1996 and 1999 (Porter et al., 1999). Scientists do not know why so many species have simultaneously become susceptible to disease.

Our current state of knowledge makes it difficult to unravel the relative roles of natural processes and human influence, whether from chemical pollution, nutrient enrichment, or climate change. But scientists are finding increasing human influence on the environment.

For example, in Puget Sound, PCB contamination may be a factor in the decline of orcas, or killer whales, whose numbers have declined by 14 percent since 1995. PCB levels in the Puget Sound population exceed that known to suppress immune function in another marine mammal, the harbor seal (Forney et al., 2000; Ross et al., 2000). Similarly, increased levels of PCBs, DDT, and tributyltin (a component in boat paint) may be contributing to the deaths of California southern sea otters. Scientists have also discovered that increasing sea-surface temperatures are associated with the northern spread of a pathogen that attacks the eastern oyster. The pathogen, *Perkinsus marinus*, was itself likely introduced into the U.S. Atlantic and Gulf coasts via aquaculture.

The crisis in our oceans is such that many marine populations and ecosystems may be reaching the point where even a small disturbance can cause a big change. We must

BOX TWO

Steve Simonsen/Marine Scenes

ECOSYSTEM HEALTH

Ecosystem-based management requires defining standards of ecosystem health. Maintaining, protecting, and, where appropriate, restoring ecosystem health should be the goal of our new ocean governance.

Marine ecosystems are too varied and complex to write a single definition—scientific or legal—of health. However, as in human health, where we take basic measurements such as temperature, blood pressure, and cholesterol, we can identify and measure certain parameters in marine ecosystems to learn more about their health. These parameters include the number of species, population sizes of species, water quality, and habitat composition. Marine scientists need to develop an understanding of what good health means for each major ecosystem in U.S. ocean waters, and then policymakers and those who use ocean resources need to practice preventive medicine.

The term "ecosystem health" refers to the ongoing capability of an ecosystem to support a productive and resilient community of species, irrespective of the human activity permitted there. This requires a holistic approach to management, focusing not only on individual species but also on the interactions among them and their physical environment. A healthy ecosystem is capable of providing ecological goods and services to people and to other species in amounts and at rates comparable to those that could be provided by a similar undisturbed ecosystem.

Although often taken for granted, the goods and services provided by coastal and marine ecosystems would be difficult—if not impossible—to replace. These benefits include protection from coastal storm damage, the filtering of toxic substances and nutrients, production of oxygen, and sequestration of carbon dioxide. In addition, fishing, tourism, and recreation provide economic benefit, and support ways of life that contribute to the social and cultural wealth of the nation.

therefore initiate large changes ourselves, not in the oceans, but in our governance of them and our attitude toward them. We must no longer structure our thinking in terms of maximizing the short-term commercial benefit we derive from the oceans, but rather in terms of maximizing the health and persistence of ocean ecosystems (Box Two).

Addressing the crisis of our seas will require a serious rethinking of ocean law, informed by a new ocean ethic. The legal framework that governs our oceans is more than 30 years old, and has not been updated to reflect the current state of ocean resources or our values toward them. The last comprehensive review of our ocean policy was completed in 1969, when the Stratton Commission produced its seminal report, *Our Nation and the Sea.* The recommendations of the Stratton Commission, including the establishment of the National Oceanic and Atmospheric Administration and the enactment of the Coastal Zone Management Act, provided the blueprint for U.S. ocean policy (Cicin-Sain and Knecht, 2000). But our oceans and coasts—and our society as well—have changed dramatically since that time.

For example, nearly 30 years ago, in response to outrage over foreign overfishing of abundant fish populations off America's

FIG. TWO

Art: John Michael Yanson

Coral reefs—often called the "rain forests of the sea"—are among the most diverse ecosystems on the planet. Pollution, destructive fishing activities, coastal development, and climate change contribute to the declining health of the world's reefs.

shores, Congress took action to develop a domestic fishing industry and capture the wealth of fisheries for this country. Today, the problem is reversed. We are overfishing our already depleted fish populations, harming marine ecosystems, and leaving fishermen out of work.

Over the past three decades our understanding of the oceans has also evolved. For too long we viewed the ocean as a limitless resource. We now know that ocean life is finite. We overlooked the connections between the land and sea. Now, we know that our activities on land—from building roads to logging trees to damming rivers—have a direct impact on the oceans.

Over time, experience on land has made biologists and ecologists aware of the many linkages within and among ecosystems, fostering development of a more sophisticated approach called ecosystem-based management. An ecosystem is composed of all of the organisms living in a certain place and their interactions with each other and with their environment. Weather, currents, seafloor topography, and human activities are all important influences on ecosystems. The goal of ecosystem-based management is to maintain the health of the whole as well as the parts. It acknowledges the connections among things.

Maintaining healthy ecosystems is crucial. When we sacrifice healthy ecosystems, we must also be prepared to sacrifice economic and social stability. Indeed, once an ecosystem collapses, it may take decades or centuries for it to recover, and the species that we so valued may be permanently lost (Figure Two).

The story of horseshoe crabs is a cau-

tionary tale. Every spring, hundreds of thousands of horseshoe crabs migrate to the shores of the Delaware Bay to spawn. The crabs pile up on the beaches, where each female may lay up to 80,000 eggs.

When they spawn, as many as 1.5 million migrating shorebirds stop on the beaches to gorge themselves on the eggs. Some species, such as red knots, nearly double their weight during a two-week stopover on their migration from southern Brazil to Canada. If the birds are unable to bulk up on the eggs, they may never complete their flight north, or may fail to breed once they arrive. Small mammals, diamondback terrapins, and mollusks also feed on the eggs.

By the mid-1990s, scientists began to notice declines in horseshoe crab and shorebird counts. The declines coincided with an increase in offshore trawling for the crabs, which are sold as bait to catch eels and whelks. According to the National Marine Fisheries Service, the catch of horseshoe crabs in New Jersey, Delaware, and Maryland doubled between 1990 and 1994 to at least a half million crabs a year.

During this period, horseshoe crab counts on spawning beaches were down dramatically, on some beaches by 90 percent. The number of shorebirds declined sharply as well. Also threatened is a multimillion-dollar ecotourism industry centered on the annual bird migrations.

TOWARD AN OCEAN ETHIC

In July 2000, the Pew Oceans Commission embarked on a journey of inquiry. We sought to understand the state of our oceans and the effectiveness of the nation's ocean policy. Our approach encompassed extensive research, consultation with scientific and policy experts, and testimony from Americans whose lives are intertwined with the ocean. We identified three primary problems with ocean governance. The first is its focus on exploitation of ocean resources with too little regard for environmental consequences. The second is its fragmented nature—institutionally, legislatively, and geographically. Third is its focus on individual species as opposed to the larger ecosystems that produce and nurture all life in the sea.

To correct this situation, we have identified five main challenges and corresponding recommendations for revising our laws and institutions. The five challenges are: reforming ocean governance, restoring America's fisheries, protecting our coasts, cleaning coastal waters, and guiding sustainable aquaculture.

New laws and policies, however substantial, are not enough. A more fundamental change is needed. A change in values—not only what we value, but how we value—is essential to protecting and restoring our oceans and coasts.

Our society needs an ethic of stewardship and responsibility toward the ocean and its inhabitants. Like the conservation land ethic that has taken shape in our nation over many decades, an ocean ethic provides a moral framework to guide the conduct of individuals and society. Extending environmental protection beyond a single medium—such as air, or water, or a single species of plant or animal—to entire ecosystems is both a practical measure and our moral obligation as the stewards of our planet.

The Commission has framed six key principles that form the core of a new ocean ethic and that underlie all of our recommendations.

UPHOLD THE PUBLIC TRUST

The oceans of the United States are a vast public domain that is vitally important to our environmental and economic security as a nation. The public has entrusted the government with the stewardship of our oceans, and the government should exercise environmental and economic control over them with a broad sense of responsibility toward all citizens and their long-term interests. Likewise, public and private users of ocean resources should be responsible in their use and should be held accountable for their actions.

PRACTICE SUSTAINABILITY

The essence of sustainable development is using our planet's resources as if we plan to stay. In the long term, economic sustainability depends on ecological sustainability. We must reassess and, where necessary, change our actions to take out no more living things than the system can reliably replace and put in no more contaminants than the system can safely absorb. We must protect what should not be destroyed, and repair as much of the damage as we can.

APPLY PRECAUTION

Despite the wealth of knowledge we have accumulated, there is a great deal of uncertainty in our understanding of the structure and functioning of coastal and marine ecosystems. However, we depend on ecological and economic goods and services provided by healthy marine ecosystems. In the face of uncertainty, we should err in our decisions on the side of protecting these ecosystems.

RECOGNIZE INTERDEPENDENCE

Human well-being and the well-being of our coasts and oceans are interdependent. We depend on marine ecosystems, and they depend on our respectful treatment. Other interdependencies are likewise crucial: between land and sea; among species and between species and their habitats; among all levels of government with jurisdiction over the marine environment; and among government, the public, and the users of coastal and marine resources. An ocean ethic requires us to understand these connections, and use that knowledge wisely.

ENSURE DEMOCRACY

Our current system of ocean governance, and the patterns of ocean use resulting from it, too often allows the needs and desires of a few to dictate the availability of benefits for all of us. The public should be able to count on governance decisions that respect broad and long-term societal goals; and to be confident those decisions are made by institutions that are accessible, efficient, and accountable through processes that are transparent and collaborative.

IMPROVE UNDERSTANDING

We know enough about coastal and marine ecosystems to improve their sustainable use. With better information, we could do much more. Public and private institutions need to work together to fill the gaps in our knowl-

edge and to ensure that decision-makers have timely access to the information they need to protect the public interest. In addition, they need to provide the public with understandable information about the structure and functioning of coastal and marine ecosystems, how ecosystems affect our daily lives, and how we affect ecosystems.

The scope of the problems before us requires sweeping change. With a strong ocean ethic to anchor us, we must place conservation of ocean ecosystems and resources as the primary goal of a new national ocean policy.

Waving sea fans and octocorals frame a blue angelfish in the waters of Florida Keys National Marine Sanctuary.

Chapter One
AMERICA SPEAKS

Knowledge of the oceans is more than a matter of curiosity. Our very survival may hinge upon it.

President John F. Kennedy

In June 2000, the 18 members of the independent Pew Oceans Commission embarked on the first national review of ocean policies in more than 30 years. They brought together their collective experiences from the worlds of fishing, science, conservation, education, government, and business to develop recommendations for a new national ocean policy to restore and protect natural ecosystems and maintain the many benefits the oceans provide.

Each member of the Pew Oceans Commission brings a lifetime of personal and professional connections to the oceans. Former Congressman and White House Chief of Staff **Leon Panetta** is chair of the Pew Oceans Commission. Mr. Panetta has lived along California's Big Sur coast his entire life and comes from a fishing family. He spent 16 years in Congress representing California's fishermen, farmers, and coastal residents. He authored the legislation establishing the Monterey Bay National Marine Sanctuary, the nation's largest marine protected area.

Mr. Panetta took over as chair after the Commission's first chair, then-Governor **Christie Todd Whitman**, stepped down to head the U.S. Environmental Protection Agency. Governor Whitman is one of four past or present governors who served on the Commission.

George Pataki is serving his second term as governor of New York, where he has spearheaded a number of important initiatives to ensure safe drinking water, clean air and water resources, and protect and improve coastal areas. **Mike Hayden** is the former governor of Kansas and past president of the American Sportfishing Association. He also served in the first Bush Administration as assistant secretary of interior for fish, wildlife, and parks. **Tony Knowles** recently completed two terms as governor of Alaska. The former mayor of Anchorage served on the North Pacific Fishery Management Council, and brought his depth of experience to bear as chair of the Commission's governance committee, one of four such committee chairs.

Kathryn Sullivan is a former astronaut and chief scientist for NOAA, the National Oceanic and Atmospheric Administration. Dr. Sullivan currently directs a hands-on science center in Columbus, Ohio, devoted to the public understanding of science and improving science education. She chaired the Commission's pollution committee. **Joseph Riley** has served as mayor of Charleston, South Carolina, since 1975. During this time, he has become a leading expert on urban design and livability issues and is a founder of the Mayors' Institute for City Design. Mayor Riley served as chair of the coastal development committee. **Eileen Claussen** is president of the Pew Center on Global Climate Change. She is a former assistant secretary of state for oceans, environment, and science. She chaired the Commission's fishing committee.

Commercial fishermen **Pat White**, a lobsterman from York, Maine, and **Pietro**

Parravano, a salmon fisherman from Half Moon Bay, California, gave the Commission a look into the lives of America's fishing families through their own experiences and by hosting a series of discussions with fishermen all around the country. **Carlotta Leon Guerrero** brought the concerns and unique perspectives of the residents of Guam, where she is a past member of the senate, and of the Pacific islanders in general. **John Adams** of the Natural Resources Defense Council and **Roger Rufe** (Vice Admiral, United States Coast Guard, Retired) of The Ocean Conservancy represented the interests of hundreds of thousands of citizens concerned about the marine environment.

Throughout its deliberations, the Commission sought the best available scientific information, beginning with its choice of commissioners. **Jane Lubchenco** is a professor of marine biology at Oregon State University and past president of the American Association for the Advancement of Science and the Ecological Society of America. **Charles Kennel** is the director of the Scripps Institution of Oceanography in San Diego. **Geoffrey Heal** is a professor of economics and finance at Columbia University. Along with Dr. Sullivan, they ensured a solid scientific basis for the Commission's deliberations.

As CEO of American Water Works Company, the nation's largest private drinking water utility, **Marilyn Ware** brings extensive business experience to the Commission. **David Rockefeller, Jr.**, vice chair of the National Park Foundation and trustee of the Rockefeller Brothers Fund, and **Julie Packard**, executive director of the Monterey Bay Aquarium and vice chair of the David and Lucile Packard Foundation, are active in the areas of philanthropy, the environment, and education.

In the ensuing two and a half years, commissioners traveled around the country to learn firsthand about the problems facing our oceans. Along the way, they spoke with thousands of citizens who live and work along the coasts. They heard from dozens of leading scientists and published a series of reports on pollution, coastal development, marine reserves, fishing, aquaculture, and introduced species.

Commissioners traveled from Maine to Hawaii, from the Gulf of Alaska to the Gulf of Mexico. They studied coastal development in Charleston, South Carolina, and Portland, Oregon. They met with sportfishermen in Florida, lobstermen in Maine, salmon fishermen in Kodiak, and crabbers in Baltimore. The Commission toured aquaculture facilities in Maine, Florida, and Washington, and a pineapple plantation in Hawaii. Commissioners reviewed habitat restoration programs in South Carolina, Maine, and California. They traveled to Des Moines, Iowa, to talk with farmers about ways to limit polluted runoff from fields and feedlots.

The story that unfolded is one of a growing crisis along America's coasts. Although the issues and circumstances vary from community to community, the Commission found a shared sense of urgency and commitment to reverse the decline in the health of the oceans.

What follows is a sampling of what the commissioners heard and learned at public hearings held in cities around the nation.

MONTEREY, CALIFORNIA

November 27, 2000

Several dozen fishermen, scientists, environmentalists, and state and local government officials attended the Commission's first public hearing in Monterey, California. The setting was appropriate: Monterey was once a thriving fishing community. Its Cannery Row was made famous by novelist John Steinbeck. However, the sardine fishery collapsed in the mid-20th century, and other California fisheries have followed suit. At the time of the Commission's hearing, there was a growing sense of crisis regarding the previously robust bottom fish fishery. The population of bocaccio rockfish, commonly sold as Pacific red snapper, and other bottom fish had plummeted to historic lows, signaling the difficulties the fishery would soon face.

Zeke Grader, of the Pacific Coast Federation of Fishermen's Associations, directly addressed this crisis: "Our concern is that this industry may soon be gone if we don't develop strong ways of protecting oceans and ocean systems for the future livelihood of fishing communities."

Today, Monterey is a world-renowned center for ocean research, exploration, and education, and leading scientists addressed the Commission.

Marsha McNutt, director of the Monterey Bay Aquarium Research Institute and chair of a presidential panel on ocean exploration addressed the panel saying, "It has been stated many times that we know more about the backside of the moon than we do about the bottom of our ocean. We have just begun to learn about the diversity of life in all reaches of the ocean, and the cycling of its critical elements that support life and regulate climate."

Dr. McNutt noted that scientists exploring the deep canyons off Monterey routinely discover ocean animals previously unknown to science. She compared the significance of the discoveries to "knowing about cats but having never seen a lion."

Other people testified to the problems confronting marine mammals, including sea otters. Jim Estes of the U.S. Geological Survey and the University of California, Santa Cruz, described how the sea otter's remarkable recovery from near extinction is now in jeopardy. "Protecting sea otters from hunting is not enough," said Dr. Estes. Sea otter declines as far north as Alaska indicate that factors such as coastal pollution, habitat disturbances, and the ripple effects of overfishing on ocean food webs are taking a growing toll on sea otter survival.

While in the Monterey area, the Commissioners visited the Elkhorn Slough National Estuarine Research Reserve—one of more than two dozen such protected areas managed jointly by state and federal governments—and the Monterey Bay National Marine Sanctuary, the largest of a national network of marine sanctuaries. Both of these protected areas offer successful examples of bringing different interests together from across a region to protect and maintain coastal and ocean ecosystems.

MAUI, HAWAII

February 7, 2001

Native Hawaiians, coral reef experts, and long-line fishermen were among nearly 100 people

who attended the public hearing in Maui. The hearing coincided with the announcement of court-ordered restrictions on the longline fishery to protect endangered sea turtles. This contentious issue, however, is not limited to Hawaii; it affects the entire western Pacific, as did many of the issues addressed in Maui.

Robert Richmond, a marine biologist at the University of Guam, addressed the dire state of the world's coral reefs, highly diverse and productive ecosystems often compared to rain forests. Dr. Richmond noted that living coral reefs—including those off Hawaii that account for 70 percent of the U.S. coral reefs—are of considerable ecological, economic, and cultural value. Coral reefs provide the sand that blankets tropical beaches and protects these same shorelines from waves and erosion. They provide nurseries and protection for myriad marine life important to commercial fisheries and tourism, and they are central to island cultures. Dr. Richmond detailed the consequences of poorly planned development, coastal pollution, and destructive fishing practices, which has led scientists to estimate that 70 percent of the world's coral reefs may disappear within 40 years.

Kahu Charles Kauluwehi Maxwell, who has been working to protect Hawaii's natural resources and native traditions for decades, described how the decline of ocean resources has affected Hawaii's native people.

"A true indicator that something's wrong is when we as *Kanaka Maoli*, native people, cannot meet our basic needs from the ocean," he said. As an example, Maxwell described the loss of *limu*, seaweed that Hawaiian natives have traditionally used for condiments, nourishment, and spiritual and medicinal purposes. "It does not grow in the ocean anymore," he said.

Maxwell recalled the centuries-old concept of *Ahu Pua'a*, which allocated land in sections that extended from the top of a mountain to the coastal ocean below. This system implicitly respected the connection between the land and the sea. "The ancient Hawaiians had a deep respect for land as it was the children of the gods."

Captain Jim Coon also emphasized the need to respect our natural resources. Coon comes from a fishing family, although since the early 1970s he has made his living watching wildlife instead of catching it. Coon started Trilogy Excursions, Maui's oldest sailboat company. "We found that the most important agent for change was education and we had a captive audience with our tourists. In the late '70s and early '80s, the message was 'save the whales.' Twenty years later, the humpback whale population has grown tenfold. It is our continuing goal to show, by example, that the ocean-tourism industry can be profitable and operate in a manner that is environmentally responsible and embraces core Hawaiian values," he said.

While in Hawaii, Commissioners also met with fishermen near Kihei, Maui. "We want fisheries that will last for seven generations, as opposed to fishing it all out and putting the money in the bank," explained William Aila, who trolls and handlines for tuna from his 21-foot boat. He pointed to the vessel monitoring system as a promising management tool for preserving small boat fishermen like him. "Large vessels are supposed to fish at least 75 miles offshore, while small vessels stay with the 50-mile range. The vessel monitoring system offers a

practical and inexpensive way of ensuring compliance," he said—offering the Commission the type of practical, constructive advice they would hear across the nation from fishermen and others struggling to find solutions.

Commissioners also toured a pineapple plantation to learn about efforts to curb polluted runoff and heard from local officials about ways to manage development to preserve coastal habitats. The Commission would review similar issues at its next regional meeting.

CHARLESTON, SOUTH CAROLINA

March 27, 2001

Close to 100 people packed the Commission's daylong public workshop on coastal development held at the College of Charleston. Many in the room were students from local colleges, as well as scientists and fishermen. Interest in the topic had recently been piqued by the release of a Clemson University study that projected the region's urban area would grow by 230,000 acres in 15 years, more than twice the size of Charleston's existing urban area. The report urged action on existing local development plans to preserve open space and the region's coastal habitats.

Similarly, in his report prepared for the Commission, Dana Beach of the South Carolina Coastal Conservation League found that some large coastal metropolitan areas consume land 10 times as fast as they add new residents. Furthermore, Beach reported that if today's land consumption trends continue, more than one-quarter of the coast's acreage would be developed by 2025.

"These trends are a prescription for severe ecological damage," said Beach. "Abundant research on rivers and estuaries confirms that when impervious surfaces cover more than 10 percent of a watershed, the rivers, creeks, and estuaries they surround become biologically degraded."

Personal experience testified to this trend. In the early 1950s, Fred Holland and his brothers spent their summer vacations in Myrtle Beach. "We could gather enough fish, crabs, and oysters from the tidal creeks to feed us for the week. Today, it is unsafe to eat the shellfish from most of the creeks and too few fish occur in them to make fishing worthwhile," Holland told the Commission. Today, he runs the Hollings Marine Laboratory, and leads efforts to preserve the state's tidal creeks and estuaries.

"The hardest thing I have ever worked on is conversion of the science we developed for tidal creeks into land-use ordinances that did not infringe upon property rights," he said. However, after years of meetings with the public, land-use planners, and decision-makers, Holland said the efforts paid off. "We passed comprehensive land-use plans that maintained the quality of life and protected critical natural resources. These plans are far from perfect. They are, however, a major step in the right direction."

Vince Graham spoke to the Commission about his experiences as a developer in the region. "I used to think that people are bad. More people are worse. I sometimes refer to it as the 'hate thy neighbor' syndrome, and think it is a direct outgrowth of the damaging way we have grown over the past five decades with zoning laws placing quantity over quality. What we see now is an emphasis on inclusiveness and community, where neighborhoods get bet-

ter over time. This form of development leads to a certain connectedness among residents that is absent in conventional subdivisions."

Development was also on the minds of fishermen who came to Charleston to meet with the Commission. Ben Hartig talked about the increasing number of fishermen who can no longer afford to live along the coasts and must wake up hours earlier to tow their boats to the water from new homes far inland. Others worried about the loss of working waterfronts and the infrastructure needed to support the industry, as bait shops and boat repair businesses give way to condominiums and art studios.

However, development is only one part of the challenge facing fishermen. Tony Iarocci, a commercial fisherman from Marathon, Florida, believes that fishermen must stay engaged. "From New England to Alaska, there are representatives of the commercial fishing industry who should be included in any new national policy regarding America's oceans, with an emphasis on sustaining the productivity and diversity of the oceans' resources and all user groups. It is time all resource users put aside their personal agendas and work together."

ROCKPORT, MAINE

June 13, 2001

Nearly 200 people, including lobstermen, representatives of the aquaculture industry, environmentalists, citizens, and local politicians attended the Commission's hearing in Maine. The Commission's visit came at a time when fishermen, scientists, and fishery managers continue to work toward rebuilding the region's once-abundant groundfish fisheries.

Although Maine has had long-standing problems with depleted fisheries, the Commission encountered one of the best examples of innovation in fishery management: the lobster fishery. Early on a foggy morning, commissioners went lobstering with Captain Bob Baines and Captain David Cousens to learn about the fishery's innovative management strategy, put in place in 1996. Lobster is the highest revenue-producing fishery in the northeastern United States, generating 325 million dollars from 87.5 million pounds of lobster. Entire communities along Maine's rugged coastline depend upon the lobster fishery.

The Commission heard from James Wilson, professor of Marine Sciences at the University of Maine; fishery consultant Robin Alden; Patrice Farrey of the Maine Lobstermen's Association; and others about the fishery's sometimes-contentious co-management system that jointly involves fishermen, scientists, and managers in decision-

Justin Kenney/Pew Oceans Commission

During their visit to Maine, commissioners went lobster fishing off Spruce Head. Captain Bob Baines talks with Leon Panetta about innovative measures to manage the highest revenue-producing fishery in the Northeast.

making. Captains Baines and Cousens talked about the benefits of new trap and size limits, restrictions on catching female lobsters, and the creation of lobster zones that resulted from this collaborative approach.

Other fishermen expressed concern about the region becoming too dependent on lobster alone—as other fisheries become depleted—especially if the lobster fishery begins to decline. Captain Steve Train, a commercial fisherman from Long Island, off the Maine coast, recalled a different time.

"As a child I saw my relatives and neighbors involved in purse seining, gill netting, dragging, scalloping, tub trawling, lobstering, and more. These were all small boat fishermen who came home almost every night. The 25 boats here on the island now are all just lobster boats," Train said.

"About 180 people live here year-round. Fifty to sixty of us are fishermen…. We are the ones who have children in the school, volunteer in the fire department, and serve on the school boards. The ability to adapt and move among different fisheries is what keeps us and our communities alive."

The Commission also heard considerable testimony about the growth of marine aquaculture in Maine, and the pros and cons of raising salmon in nearshore pens.

Donald Eley of the Friends of Blue Hill Bay voiced concerns about the impacts of aquaculture facilities on traditional fisheries and the local ecology. He questioned the effects of excess feed and feces generated from salmon operations and the use of chemical pollutants such as pesticides and antibiotics. He also raised concerns about the threat posed to wild salmon populations when farm-raised salmon escape.

Marine aquaculture is just one of many possible ways invasive species can be introduced into the natural environment, according to James Carlton, director of Williams-Mystic, the Maritime Studies Program of Williams College and Mystic Seaport. In his report prepared for the Commission and presented in Maine, Dr. Carlton described a "game of ecological roulette" playing out along our coasts as hundreds of species arrive each day by way of ships, ballast waters, fishing activities, and other means. Dr. Carlton detailed that the rate of marine introductions has risen exponentially over the past 200 years and shows no sign of leveling off (Figure One).

ANCHORAGE, ALASKA

August 15, 2001

Alaska is home to some of the world's most abundant populations of fish and marine mammals, the world's largest eelgrass beds, and the greatest aggregation of seabirds. Its diverse marine ecosystems, wetlands, estuaries, and river deltas form the basis of a traditional subsistence lifestyle and are vitally important to the cultural, spiritual, and nutritional well-being of people throughout the state. Alaskans' ties to the oceans were evident at the Commission hearing, attended by more than 200 people, including Alaska natives, commercial and recreational fishermen, marine scientists, fishery managers, fish processors, and environmentalists.

During the daylong public hearing, commissioners received testimony about a

number of pollution problems, from cruise ship pollution in Glacier Bay to the buildup of contaminants in fish and marine mammals.

Shawna Larson of Alaska Community Action on Toxics was among those who addressed the Commission.

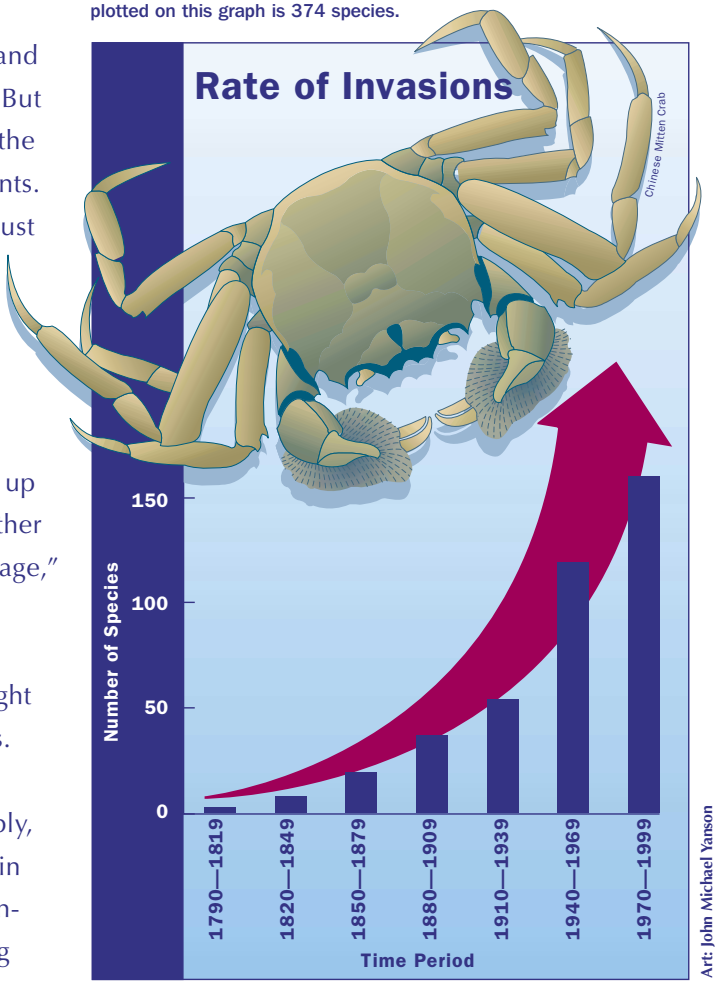
"Traditional foods are the spiritual and cultural foundation for tribes," she said. "But the traditional foods that we gather from the ocean and from the land have contaminants. My Aunt Violet points out that we aren't just eating one contaminant. We eat the whole fish. I care because it affects me personally. I have a small daughter, and I'm pregnant. I know that I'm passing the contaminants from the ocean on to my unborn baby. I want my children to grow up unafraid to eat salmon and halibut and other wild foods that are part of our tribal heritage," she said.

Fishing is Alaska's largest private employer and more than half the fish caught in the United States comes from its waters. Accordingly, the Commission heard much testimony about Alaska's fisheries—arguably, the best managed single-species fisheries in the country. With rare exceptions, the managers there have a record of not exceeding acceptable catch limits set by scientists. In addition, Alaskans have done more to control bycatch and protect habitat from fishing gear than any other region in the nation.

While justifiably proud of their record, managers were frank about some difficult issues yet to be resolved. "We don't want to paint everything up here as perfect. It's not," said David Benton, chair of the North Pacific Fishery Management Council. "But we've done a reasonably good job."

FIG. ONE

This graph shows the rate of invasions of marine invertebrates and seaweeds based upon the number of new invasions occurring in the U.S. coastal zone from 1790 to 1999. For example, there were 150 new invasions from 1970 to 1999. The total number of invasions plotted on this graph is 374 species.



Art: John Michael Yanson

Source: Ruiz et al., 2000.

The Commission also heard testimony about the threats posed by overfishing, its effects on marine mammals, including the Steller sea lion, and pollution from cruise ships.

Following the public hearing, Commissioners traveled to Kodiak, Alaska, the second-largest island in the United States and a major

fishing hub. In Kodiak, as elsewhere in the state, commissioners spoke with fishermen, scientists, and fishery managers. Kodiak's docks are home to more than 700 trawl, longline, and crab vessels. The city boasts world-class ocean research facilities and bustling canneries.

In a meeting held at the Fishermen's Hall, commissioners learned that despite the wealth of the seas, salmon fishermen were losing ground because they could not compete with low-priced farmed salmon flooding the market. They also heard about the pros and cons of the fishery management technique known as IFQs, or individual fishing quotas. IFQs divide the total allowable catch and assign portions of it to individual fishing enterprises.

NEW YORK CITY, NEW YORK

November 29, 2001

Under the 96-foot-long blue whale in the American Museum of Natural History's Hall of Ocean Life, the Commission met with more than 100 people. The interesting mix included fishermen from Long Island, authors, a chef, academics, environmentalists, and government officials.

In New York, as elsewhere, local and regional issues regarding the oceans and coasts were prominent in the news, as debate continued over whether to require General Electric to remove PCB contaminants from the Hudson River, which the U.S. Environmental Protection Agency later ruled it must.

In his testimony before the Commission, Theodore Roosevelt IV called upon all Americans to extend our conservation ethic to the sea.

"With the possible exception of our coasts, the state of our oceans is largely overlooked," he said. "It was the devastation to wildlife on the American plains that President Theodore Roosevelt witnessed during his ranching and hunting days that inspired his own conservation ethos. He realized then that we were pushing species beyond their ability to recover. While much of conservation is driven by well-founded moral considerations, we must not overlook the fact that we also conserve in order to survive…. We are the stewards of tomorrow's prosperity and security."

Rick Moonen, chef and owner of rm Restaurant in New York, came to the hearing straight from his kitchen, dressed in his white chef's outfit. Moonen said that he is constantly aware of the oceans. "As a chef, I make my living out of selling seafood. Chefs work with the product—fish, shellfish—every day. So, I notice things. I don't think of myself as an activist. I'm just a businessperson looking into the future and not liking the picture I see. We—chefs, consumers, fishermen, and policymakers—have a responsibility to ensure that the seafood choices we make today are the best ones for the ocean."

Bonnie Brady, executive director of the Long Island Commercial Fishing Association, with two children in tow, urged the Commission to remember that, "Those working to achieve sustainable fisheries should not leave out of the equation the fishermen and their communities…and remember that humans are part of the environment."

Brady's husband, Dave Aripotch, works out of Montauk, Long Island, aboard his 70-foot dragger, *Cory & Leah*, and a 65-foot dragger, *Samantha & Mairead*. "In our community, the commercial fishing community

is probably about 200 to 300 people, plus an additional 200 to 300 people employed by the charter boat and recreational fishing industries. We have every kind and size of boat you can imagine: 12-foot clamming skiffs, 40- to 60-foot inshore draggers, 50- to 60-foot longliners, and 65- to 90-foot offshore draggers. Commercial fishing here is 24/7, fishing for flounder, fluke, cod, haddock, whiting, squid, porgies, tilefish, tuna, lobsters, clams, and more."

While in New York, commissioners toured habitat restoration and waterfront redevelopment projects along the New York and New Jersey shorelines. They visited the Fulton Fish Market—the nation's largest wholesale seafood market—getting a glimpse of the scale of the industry in this megalopolis.

Deb Antonini/Pew Oceans Commission

Retired Coast Guard Vice Admiral Roger Rufe, president of The Ocean Conservancy, welcomes his fellow commissioners aboard the U.S. Coast Guard cutter Katherine Walker *during the Commission's visit to New York.*

DES MOINES, IOWA

December 10, 2001

Des Moines is situated near the heart of the Mississippi River watershed, which drains more than 40 percent of the continental United States into the Mississippi River and ultimately into the sea.

It was appropriate, therefore, that this one-day hearing in Des Moines featured presentations from agronomists and marine biologists as well as farmers and fishermen. Throughout the day, panelists and public commentators drew connections between farming practices in the heartland and the health of our waters.

Susan Heathcote of the Iowa Environmental Council spoke to the Commission. "I am here because I am concerned about the impact that nutrient pollution from Iowa and the upper Midwest is having on the Gulf of Mexico," she said. "But I am also concerned about the impact of nutrient pollution on the health of Iowa's water resources."

In the marine pollution report he prepared for the Commission, Dr. Donald Boesch of the University of Maryland found that nutrients running off our farms and cities have emerged as the most widespread pollution problem for coastal waters. As these nutrients flow off our farm fields, lawns, and golf courses to our coastal waters, they in effect "fertilize" the oceans, triggering a depletion of the oxygen and degradation of habitat that marine species need to survive. The result: dead zones where no life exists, including such a zone off the mouth of the Mississippi River that has in recent years grown as large as Massachusetts (Figure Two, page 22).

For the Commission, the Des Moines hearing highlighted this problem of nutrient pollution. The Mississippi—like the Hudson, the Susquehanna, the Columbia, and America's other great rivers—has become an expressway for nutrients and toxic substances bound for the sea.

Nancy Rabalais of the Louisiana Universities Marine Consortium pointed to

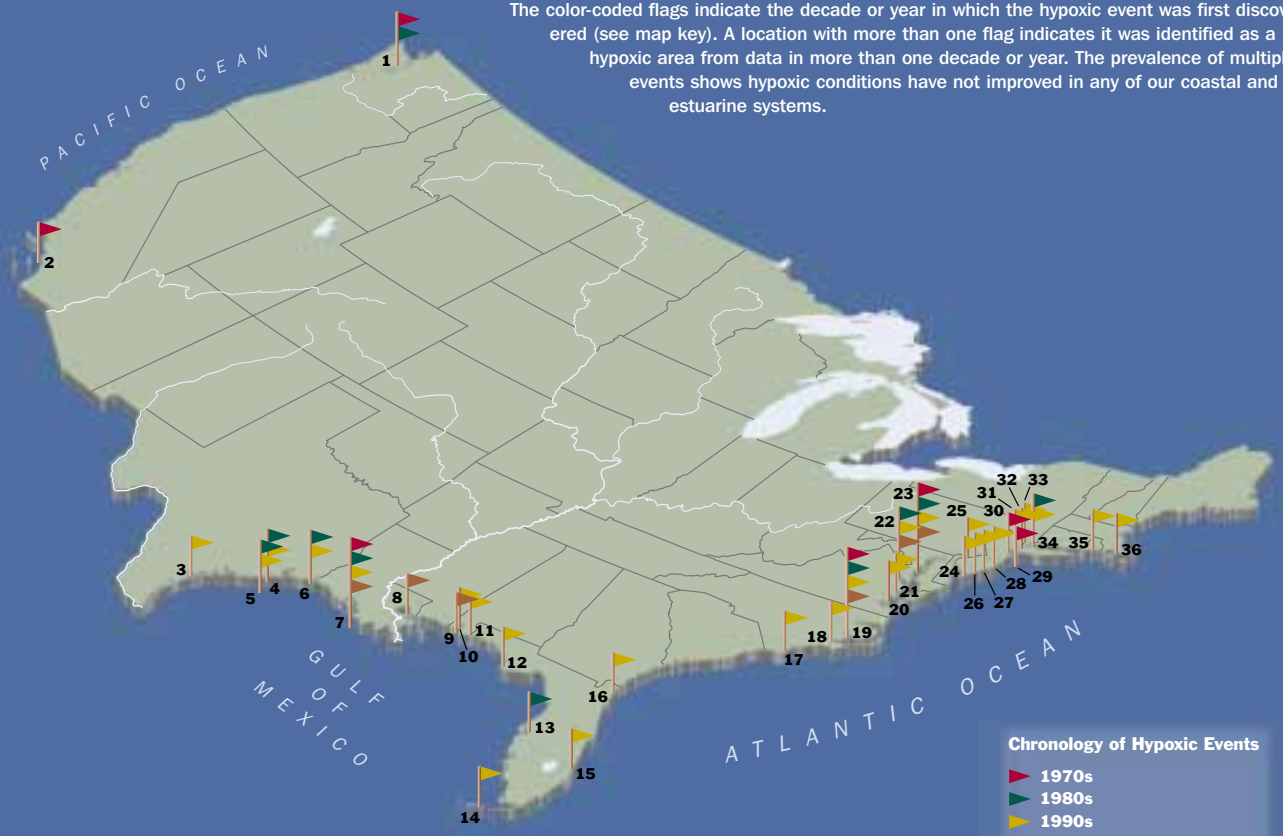
FIG. TWO

U.S. Coastal Dead Zones Associated with Human Activity

Many coastal ecosystems around the United States have documented low levels of dissolved oxygen, a condition known as hypoxia. Often these hypoxic areas—also known as dead zones—are a result of both natural and anthropogenic events. The map below shows the distribution of dead zones in U.S. coastal waters that are associated with human activity.

Dead zones are concentrated along the Atlantic and Gulf coasts because of the proximity of heavily populated areas and the intense agricultural practices that create the discharge of large quantities of nutrients into coastal waters. Warmer summer temperatures in these waters stratify the water column, a component in the development of hypoxia. Waters along the Pacific coast of the U.S. are not prone to stratification of the water column.

The color-coded flags indicate the decade or year in which the hypoxic event was first discovered (see map key). A location with more than one flag indicates it was identified as a hypoxic area from data in more than one decade or year. The prevalence of multiple events shows hypoxic conditions have not improved in any of our coastal and estuarine systems.



1 Hood Canal
2 Los Angeles Harbor
3 Corpus Christi Bay
4 Texas Shelf, Shallow
5 Texas Shelf, Deep
6 Freeport
7 Louisiana Shelf
8 Lake Pontchartrain
9 Bon Secour Bay
10 Mobile Bay
11 Perdido Bay
12 St. Joseph Bay
13 Hillsborough Bay
14 Florida Keys
15 St. Lucie River
16 St. Johns River
17 Cape Fear River
18 Neuse River
19 Pamlico River
20 York River
21 Rappahannock River
22 Potomac River
23 Chesapeake Bay Mainstem
24 Townsend-Hereford Inlet
25 Delaware River
26 Great Egg Harbor River
27 Mullica River
28 Barnegat Inlet
29 New York Bight
30 Raritan Bay
31 New York City Harbor
32 Flushing Bay
33 Hudson River
34 Long Island Sound
35 Pettaquamscutt River
36 Waquoit Bay

Source: Robert J. Diaz, College of William and Mary, Virginia Institute of Marine Science. This map is based solely on data from published scientific research.

Map: Jerome N. Cookson

successful efforts to curb nutrient runoff in the U.S. and around the world as reason to be hopeful. "The growing decline of coastal water quality nationwide and globally, but also the proven successes of reducing nutrients, are reasons enough for continued and expanded efforts to prevent excess nutrients from reaching the sea," Dr. Rabalais told the Commission.

NEW ORLEANS, LOUISIANA

March 15, 2002

Commissioners traveled to New Orleans and the mouth of the Mississippi River to consider the pollution issues raised in Des Moines and other issues facing the Gulf of Mexico and its residents. About 75 people gathered in a Bourbon Street hotel, including members of the U.S. Army Corps of Engineers, state politicians, scientists, environmentalists, shrimpers, and recreational fishermen. The hearing coincided with the release of a new report from the Governor's Committee on the Future of Coastal Louisiana.

King Milling, chair of that committee and president of Whitney National Bank, spoke for many coastal residents when he addressed the Commission.

"The loss of Louisiana's marshes will incrementally destroy the economy, culture, ecology, and infrastructure, not to mention the corresponding tax base of this state and this region," he said. "From an ecological and environmental point of view it is a clear disaster. The very existence of coastal towns and communities will be called into question. Many of them will have to be abandoned. Jobs will be lost. Lives will be disrupted and, in many instances, placed at risk."

The committee has called for a $14 billion investment from state, federal, and private sources to correct the runaway erosion of Louisiana's coastline, exacerbated by the Corps of Engineers' efforts to tame the Mississippi River.

Before the Commission's hearing, shrimp fisherman Michael Roberts and his wife, Tracy Kuhns, invited several of their fellow fishermen to their home in Barataria, Louisiana, to talk with the Commission about the fishing industry. They spoke about increased competition from imported shrimp—much of it caught or farm raised in countries lacking sufficient environmental safeguards. They expressed frustration at watching refrigerator trucks full of imported shrimp drive from the airport to local processing plants, while they are unable to sell their local catch. Others talked about the effects of the continued loss of wetlands, which serve as nurseries for many commercially important fisheries, as well as about the problems of pollution and coastal development.

THE BIG PICTURE

In addition to their regional meetings, members of the Pew Oceans Commission traveled to Portland, Oregon, to study coastal development; held a fishery management workshop in Seattle, Washington; and hosted a workshop on ocean governance in Monterey, California.

Commissioners attended conferences on marine aquaculture in San Diego, California, and Providence, Rhode Island. They met with hundreds of fishermen, including a public hearing with recreational fishermen at the International Game Fish Association Hall of Fame and Museum in Dania, Florida. All told, commissioners spoke with thousands of scientists, fishermen, students and teachers, coastal residents, businessmen and women, government officials, and countless others. They found an outpouring of concern and a shared commitment to restore, protect, and maintain the health of the oceans for the benefit of current and future generations.

Part Two

A PUBLIC GOOD AT RISK

Cushion sea stars, Virgin Islands National Park, U.S. Virgin Islands
Steve Simonsen/Marine Scenes

Chapter Two
GOVERNANCE FOR SUSTAINABLE SEAS

...laws and institutions must go hand in hand with the progress of the human mind. As that becomes more developed, more enlightened, as new discoveries are made, new truths discovered and manners and opinions change, with the change of circumstances, institutions must advance also to keep pace with the times.

Thomas Jefferson
In a letter to Samuel Kercheval, July 12, 1816

Dams in the Columbia River basin have devastated salmon populations in the Pacific; fertilizer running off fields in the corn belt has created a huge dead zone in the Gulf of Mexico one thousand miles away; declines in sea otters lead to the loss of kelp forests. The land is connected to the ocean and the oceans themselves are complex systems of interrelated parts. Yet, we have approached them as though they are collections of disconnected components, problems, and opportunities.

To govern the oceans for the long-term public good, we need to manage with the entire ecosystem in mind, embracing the whole as well as the parts. The preeminent goal of our ocean policy should be to protect, maintain, and restore marine ecosystems. To reach this goal, we must first understand the fundamental problems of today's laws and programs.

FRAGMENTED LAWS, DIVIDED WATERS

Governance is a reflection of the knowledge and values of the society that creates it. Our ocean governance needs updating to reflect substantial changes in our knowledge of the oceans and our values toward them since our major ocean laws, policies, and institutions were established.

Not a system at all, U.S. ocean policy is a hodgepodge of individual laws that has grown by accretion over the years, often in response to crisis. More than 140 federal laws pertain to the oceans and coasts (Box One). Collectively these statutes involve at least six departments of the federal government and dozens of federal agencies in the day-to-day management of our ocean and coastal resources.

Authority over marine resources is fragmented geographically as well. The Submerged Lands Act of 1953 gave most states authority over submerged lands and overlying waters from the shoreline out three miles. Federal territorial sovereignty extends 12 miles offshore, and, consistent with the United Nations Convention on the Law of the Sea, the federal government controls ocean resources out 200 miles or more. This federal/state division of ocean jurisdiction makes it difficult to protect marine ecosystems because it divides their management into a nearshore and an offshore component with insufficient means or mandate to harmonize the two.

FAILING ECOSYSTEM, FAILED GOVERNANCE

The plight of salmon in the Pacific Northwest illustrates the complex problems facing our oceans and coasts, as well as the problematic nature of our response. The Northwest's Columbia River Basin was historically spawning ground for some 10 to 16 million salmon that returned from the Pacific Ocean each year to lay their eggs. But decades of damming,

Steve Simonsen/Marine Scenes

LAWS OF THE SEA

Beginning 30 years ago, a formidable body of environmental law was enacted in the United States to protect our air, water, coastal zone, endangered species, marine mammals, and fisheries. According to a recent study by the Sea Grant Law Center of the University of Mississippi (Sea Grant Law Center, 2002), over 140 laws pertain to oceans and coasts. Forty-three of these (including three presidential proclamations) are considered major statutes.

Although our coasts and oceans would no doubt be in worse condition without them, environmental quality has nonetheless deteriorated since enactment of these laws. They were intended to address specific issues, but collectively fail to provide an overall governance framework to maintain the health of marine ecosystems.

In addition to the Magnuson-Stevens Act, which is discussed in detail in Chapter 3, a number of the major laws affecting our oceans are listed below.

■ **The Clean Water Act of 1972 (CWA)** is the primary federal statute controlling water pollution by requiring, wherever attainable, that navigable waters of the United States be made "fishable and swimmable." The CWA dramatically improved the nation's water quality by providing for the establishment of national water quality standards for pollutants, by requiring that polluters obtain and abide by the terms of a pollution discharge permit, and by establishing baseline technology that must be used to treat discharges of pollutants.

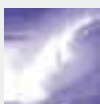
■ **The Coastal Zone Management Act of 1972 (CZMA)** established a voluntary program under which coastal states and territories could receive federal funding and technical assistance to develop programs to manage growth and development in coastal areas that is compatible with protection of natural resources. The CZMA recognized that good coastal management is in the national interest. At the same time, its structure reflects the reality that the type of land-use planning required has traditionally been a state or local government function. An important feature of the CZMA is a provision requiring that federal actions likely to affect the coastal zone be consistent with a state's coastal zone management plan.

■ **The Endangered Species Act of 1973 (ESA)** covers both terrestrial and aquatic species. The ESA prohibits the killing, injury, or harassment of species that are in danger of extinction. It establishes a process through which the secretary of the interior (generally for terrestrial and freshwater species and birds) or the secretary of commerce (generally for marine species) may designate species as endangered or threatened, triggering the protections of the act. The ESA also provides for the protection of habitat critical to the survival of endangered species and requires federal agencies whose actions are likely to jeopardize a listed species to consult with the appropriate authority (either the Department of the Interior or the Department of Commerce) regarding alternatives to the proposed action.

■ **The Marine Mammal Protection Act of 1972** was enacted in response to the public outcry over high dolphin mortality in the Pacific tuna fishery, the clubbing of baby seals, and the commercial "fishery" for whales. It generally prohibits the killing or harassment of marine mammals in U.S. waters or by U.S. citizens on the high seas. It provides for limited take of marine mammals for subsistence purposes by Alaska Natives and for take incidental to other activities, such as fishing. Its management and recovery actions focus on maintaining sustainable populations of marine mammals. The Endangered Species Act and the Marine Mammal Protection Act, while effective at protecting many species, are stopgap measures applied on a case-by-case basis that do little to address environmental factors critical to species' survival.

■ **The Ocean Dumping Act of 1972** was enacted to regulate the disposal of wastes in U.S. marine waters. It gives the U.S. Environmental Protection Agency primary responsibility for regulating the disposal of wastes at sea, except for dredge spoils, which are controlled by the Army Corps of Engineers. The 1988 amendments to the act required a phaseout of the disposal of sewage sludge and industrial wastes in the sea, a practice that ended in the early 1990s.

■ **The Oil Pollution Act of 1990** established strict liability for damages resulting from oil spills, broadened the categories of compensable damages, increased civil penalties for negligent discharges of oil, required measures to prevent oil spills, and required preparedness for oil-spill cleanup. The *Exxon Valdez* oil spill prompted passage of this act.



hydropower production, habitat loss, and overfishing have contributed to a 98 percent decline in wild salmon populations, including the extinction of Columbia River coho salmon. In the last decade, at least 12 major salmon and steelhead trout runs have been listed under the Endangered Species Act (Koehler and Blair, 2001).

Concerned about the dwindling salmon, in 1980 Congress established the Northwest Power Planning Council with the dual mission of protecting the region's fisheries and ensuring an adequate power supply. The council consists of two members appointed by each of the basin's four state governors. There is no federal representative on the council. The council develops a regional fish and wildlife restoration program but is dependent on the Bonneville Power Administration, a power marketing agency, for restoration funding.

Under this structure, the council—whose members are not required to have expertise in salmon restoration—has often rejected the recommendations of fisheries experts. Dam operators are only required to consider the council's plans in dam operations, not to adhere to them. And ultimately the water agencies have often failed to implement elements of the programs that *are* approved.

In 1999, the council's failure to halt the decline of Columbia basin salmon, highlighted by the endangered status of many salmon runs, led to the formation of a "Federal Caucus," whose goal was to ensure that federal agencies involved with salmon were working together to improve compliance with the Endangered Species Act. While the caucus may be able to improve the "fish-friendliness" of the vast dam and reservoir system of the 260,000-square-mile river basin, it alone cannot bring on board the local officials whose land-use decisions are critical to the health of tributaries.

During the period in which wild salmon have nearly vanished from the Columbia River Basin, the Bonneville Power Administration, under the Northwest Power Planning Council's guidance, has spent more than 3.5 billion dollars on salmon restoration. The fragmentation of responsibility for planning, funding, and implementing; the failure to establish firm restoration goals; the lack of legal and institutional mechanisms to ensure that restoration goals are achieved; and the failure to bring all relevant parties to the negotiating table have been major obstacles to salmon restoration in the Columbia River Basin.

GOVERNANCE THAT WORKS

In its investigations, the Commission encountered a number of examples of governance that appear to be working. Successful efforts evolved where necessity and ingenuity combined to push people to reach out across traditional jurisdictional lines, to form innovative partnerships, and to address environmental issues comprehensively.

THE ATLANTIC STATES MARINE FISHERIES COMMISSION

Every spring, hundreds of thousands of horseshoe crabs migrate from offshore onto the beaches of Delaware Bay to spawn, where each female may lay up to 80,000 eggs in the sand. These nutritious eggs provide fuel for as many as 1.5 million shorebirds that migrate to

nesting grounds in Canada. If the birds are unable to gorge themselves on the eggs, they may never complete their arduous flight north, or they may be unable to successfully breed once they arrive.

By the mid-1990s, scientists began to notice declines in horseshoe crab and shorebird counts. It is estimated that the horseshoe crab population in the Delaware Bay has been cut in half, and counts on some spawning beaches are down by 90 percent. Although man-made inlets and other shoreline alterations have probably contributed to the problem, the decline in horseshoe crabs coincided with a dramatic increase in offshore trawling for the crabs used as bait in other fisheries.

The Atlantic States Marine Fisheries Commission (ASMFC) is an interstate body empowered by Congress to develop uniform management plans for fisheries that span state boundaries and to coordinate with federal fisheries managers to ensure that interstate and federal fisheries management plans dovetail to the maximum extent possible. The ASMFC compact has a powerful compliance mechanism that allows federal intervention under certain conditions to enforce an interstate plan. In 2001, the ASMFC broke new ground in ecosystem-based fisheries management by limiting the harvest of horseshoe crabs out of concern for the impact of the fishery on shorebirds that depend on the crabs' eggs during their migrations.

Chesapeake Bay produces about 40 percent of the nation's blue crab harvest but catches have declined in recent years.

THE CHESAPEAKE BAY PROGRAM

The Chesapeake Bay is the United States' largest estuary. Its 64,000-square-mile watershed encompasses the District of Columbia and parts of six states and is home to more than 15 million people. The Chesapeake Bay is also home to more than 3,600 species of plants and animals. It is a major nesting ground along the Atlantic Flyway and yields half a billion pounds of seafood each year, including about 40 percent the U.S. blue crab harvest. However, the bay is in trouble and has been for some time.

Seagrass beds that provide nursery and foraging areas for a variety of species cover little more than 10 percent of their historic area. Water clarity, which is important for seagrass recovery, is fair to poor in most of the lower bay. Water oxygen levels remain too low in many areas to support much life. The oyster population is only about one percent of its historic level. The decline of oysters partly explains the loss of water quality: oysters feed by filtering microscopic plants called phytoplankton from the water. Before their decline,

oysters may have been able to clean the entire volume of water in the Chesapeake Bay every few days (Newell, 1988). The blue crab population declined precipitously in the early 1970s but seemed to rebound in the 1980s. The recent trend is again downward.

Concerned with declining water quality and dramatic die-offs of seagrasses, Congress, in 1983, established the Chesapeake Bay Program, whose efforts to reduce nutrient pollution and restore critical habitats through a watershed approach have become a model studied and emulated worldwide. This voluntary, cooperative effort among the states comprising the bay's watershed and the federal government set clear, ambitious goals for restoration. Although the program has not achieved all of its numerical targets, pollution has been reduced substantially in the face of dramatic population growth—and its accompanying development—in the region. A recent revision to the program included targets for habitat protection and reduction of the rate of land conversion, thus incorporating land use into the watershed equation.

THE FLORIDA KEYS NATIONAL MARINE SANCTUARY

The reef tract of the Florida Keys is the largest coral reef within the continental United States and is the third largest coral reef on the planet. It comprises a 220-mile arc of nearly continuous reef parallel to the Atlantic shore of the Florida Keys, supporting more than 400 species of fish, nearly 40 species of sponges, and more than 80 species of echinoderms.

In addition to the well-known reefs, the Florida Keys contain extensive mangrove islands and shorelines, as well as millions of acres of seagrass beds. These habitats provide food and shelter for a variety of ecologically, commercially, and recreationally important species.

By the late 1980s, the strain of competing uses on the Florida Keys' marine environment was evident. Live coral cover was decreasing and reefs in the northern half of the tract were increasingly overgrown by algae. In addition, severe water quality problems in Florida Bay, mainly related to human-induced changes in the water flowing from the Everglades, were devastating seagrass beds. Although physical damage to coral by boats and treasure salvors had long been a concern, several high-profile ship groundings on the reefs galvanized efforts in Congress to protect the Keys, culminating with the designation of a 2,800-square-nautical-mile area of the ocean surrounding the Keys as a national marine sanctuary in 1990.

The Florida Keys National Marine Sanctuary has substantially improved governance of the marine ecosystems of the Keys through the use of ocean zoning. This program relies on cooperation and coordination among federal and state agencies, involves stakeholders at all stages of the management process, practices adaptive and science-based management, provides opportunities for a variety of human activities consistent with conservation goals, and protects core conservation areas from all extractive or disruptive human activities.

LESSONS FROM THE LAND

The failure to conceive of the oceans as the largest component of our public domain, to be managed holistically for the greater public good in perpetuity, is perhaps the greatest flaw of U.S.

BOX TWO

Steve Simonsen/Marine Scenes

MARINE RESERVES

Kip F. Evans/National Geographic Society

A coral reef biologist counts fish in the Dry Tortugas Ecological Reserve.

The area of the ocean under U.S. jurisdiction protected in marine reserves—where all extractive and disruptive activities are prohibited—is a small fraction of one percent. As a comparison, 4.6 percent of the land area of the United States is protected as wilderness.

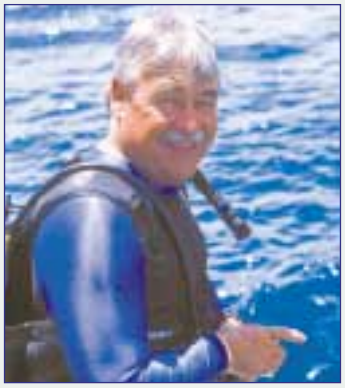
Although protecting areas on land has been a well-accepted conservation practice for more than a century, reserves are a relatively new approach to marine conservation. Reserves can improve our scientific understanding of marine ecosystems and provide enriched opportunities for nondestructive human activities and education. Recent scientific studies document that marine reserves can be effective in:

- restoring ecosystems and enhancing populations by increasing abundance, diversity, and productivity of marine organisms within reserve boundaries (Figure One, page 34);
- protecting the structure and functioning of marine ecosystems and habitats;
- replenishing adjacent areas via spillover (dispersal of juveniles and adults to adjacent areas) and larval export.

Human activities and natural phenomena constantly disturb ecosystems. Healthy ecosystems are resilient, in that they are able to resist and recover from change following a disturbance. Marine reserves increase ecosystem resilience by protecting a portion of the ecosystem, providing marine habitats and species a safe haven in which to flourish.

Protecting a variety of marine habitats within a network of reserves is vital to protect sea life that moves from one habitat to another during different life stages. A network of marine reserves is important to ensure the persistence of individual reserves by providing connectivity among them. Connectivity and linkages ensure larval dispersal and juvenile and adult migration to surrounding reserves.

A wide range of choices exists for reserve design and placement. Advances in mapping, remote sensing, and geographic information systems expand the ability of decision-makers and the public to compare alternatives. Fine-scale ocean monitoring and new research techniques that track movement of key species enhance our ability to evaluate the health of marine ecosystems. These techniques and technologies provide flexibility in choosing sites that balance social, economic, and biological considerations, and allow for effective management and evaluation.



Kip F. Evans/National Geographic Society

Superintendent of the Florida Keys National Marine Sanctuary Billy Causey prepares to dive in the Tortugas Ecological Reserve.

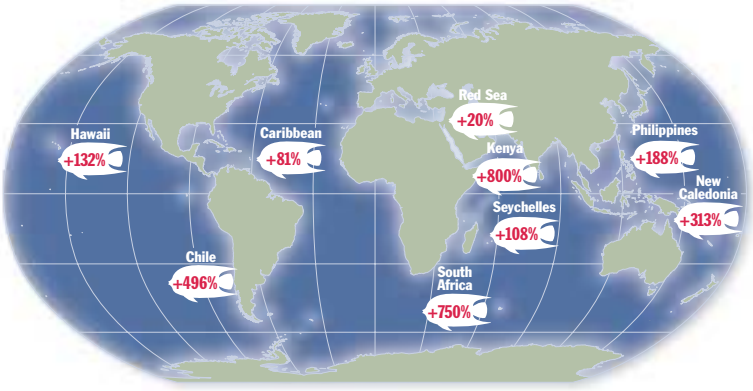
ocean policy. America's oceans span nearly 4.5 million square miles, an area 23 percent larger than the nation's land area. It is a vast three-dimensional place over which our federal and state governments exercise jurisdiction on behalf of all citizens of the United States.

Our nation's stewardship of the land, though flawed in practice, nonetheless offers useful insights for improving ocean governance. To minimize conflicts among public

FIG. ONE

Marine Reserves Increase Fish Biomass

Around the world, marine reserves have demonstrated the ability to increase fish biomass inside their borders. In most reserves studied, fish biomass doubled within five years. The larger fish found within reserves also produce more eggs. For example, ling cod within a reserve in Washington State produced 20 times more eggs per unit area than cod outside the reserve (Palumbi, 2003).



Map: Jerome N. Cookson; Art: John Michael Yanson

Source: Data are from 32 studies summarized by Halpern (2003) that were published in peer-reviewed journals.

and private uses of land, there is a well-established and detailed system of zoning on land. Used properly, zoning spatially segregates incompatible uses while providing predictability to landowners about acceptable land uses within an area. In addition, we have created a world-renowned system of public parks and wilderness areas to preserve the benefits of nature for future generations. With few exceptions, society has not extended these protections to the sea (Box Two, page 31).

At a workshop in Monterey, California, the Commission reviewed our nation's experience in managing our parks, national forests, and other public lands for possible ocean governance models. All the major land components of the public domain—the National Park System, the National Wildlife Refuge System, the National Forest System, and the public lands management by the Bureau of Land Management—have "organic acts" guiding their management. An organic act establishes the purposes of the system, its goals, and its management procedures.

Although the organic legislation guiding our public lands is flawed, these laws at least provide a framework within which the cumulative effects of all uses of public lands can be assessed, coordinated, and managed. For example, the National Forest Management Act requires the federal government to develop comprehensive forest management plans on a regional basis that take into account the wide variety of uses and benefits, including biological diversity, of our national forests. Although these plans vary widely in their attention to biological diversity, this law has improved forest management overall by establishing a clear, practicable methodology for assessing and managing forest diversity on the ground where it counts.

DEFINING ECOSYSTEM HEALTH

To successfully protect ecosystem health, we must be able to give the concept meaning in the real world. Extensive review of existing organic legislation for our public lands has shown that a major failing has been the lack of clear standards against which management actions can be measured. Ecosystem health is the standard against which actions should be measured. The Commission believes that protecting, maintaining, and—where appropriate—restoring that health should be given priority as multiple, and sometimes competing, uses are weighed.

Given the variability among ecosystems, the inherent variability within a single ecosystem, and our incomplete knowledge of their structure, functioning, and history, it is not possible to write a single definition that speci-

fies the elusive state of health for all ecosystems. However, we do know that certain characteristics are indicative of ecosystem health—number of species, populations of major species, habitat composition, and water quality, for example. With the help of marine scientists, the parameters and the range of their values that are indicative of a healthy state for each marine ecosystem can be established.

This approach has not been widely used in the oceans, but precedent exists on land. To implement the National Forest Management Act, the U.S. Forest Service has established detailed procedures for identifying and monitoring indicators of ecosystem health for each management region. The forest service focuses mainly on maintaining "viable populations" of indicator species (whose well-being is considered indicative of overall ecosystem health). In the oceans, this approach could be expanded to include other environmental quality parameters, bringing the essential task of ecosystem-based management within practical reach.

OCEAN GOVERNANCE FOR THE 21ST CENTURY

Once considered inexhaustible, the fish and other living resources of the sea are succumbing to the onslaught of our numbers and our technology. But change is coming in the way we use our oceans, if only because the oceans are changing in response to our actions.

To be effective, ocean governance must break the cycle of unsustainable marine resource use by making the shift to long-term economic and environmental thinking. Maintaining the health of marine ecosystems is in our national interest. Without productive and resilient marine ecosystems, coastal economies and entire industries would be decimated and our quality of life would be immeasurably harmed.

SUMMARY OF RECOMMENDATIONS

1. Enact a National Ocean Policy Act (NOPA).

Congress should enact a National Ocean Policy Act requiring federal, state, and territorial agencies to protect, maintain, and restore marine and coastal ecosystems, and reorienting national and regional decision-making bodies to these ends. This legislation should provide clear and measurable goals and standards to govern activities affecting the oceans, establish mechanisms to ensure compliance with the national policy, and establish national and regional institutions capable of carrying out that policy.

2. Establish regional ocean ecosystem councils.

As part of the National Ocean Policy Act, Congress should establish regional ocean ecosystem councils consisting of appropriate federal, state, and tribal representatives. These councils should be charged with developing and overseeing implementation of enforceable regional ocean governance plans to carry out the national policy to protect, maintain, and restore marine ecosystems. To be enforceable, plans must include performance goals and indicators, must be binding on all parties, and must meet federal standards established under the National Ocean Policy Act. The geographic extent of authority for each regional ocean council should be specified by statute. Each regional ocean council should establish perma-

nent advisory committees to obtain the views and advice of fishermen, scientists, environmental organizations, local government, the public, and others with an interest in ocean resources.

The regional ocean ecosystem councils should utilize ocean zoning to improve marine resource conservation, actively plan ocean use, and reduce user conflicts. Ocean zoning should allow for the protection of key habitats or resources while facilitating a variety of human activities.

3. Establish a national system of marine reserves.

Congress should enact legislation mandating the establishment of a national system of marine reserves to protect marine ecosystems, preserve our national ocean treasures, and create a legacy for our children. Congress should authorize regional ocean ecosystem councils to create marine reserves within the areas of their jurisdiction but should itself take action to protect areas of national significance.

4. Establish an independent national oceans agency.

Congress should establish an independent agency outside the Department of Commerce to address the national interest in the oceans and atmosphere. This agency should consolidate under one roof as many federal ocean programs as is practical. At a minimum, the agency should consist of the programs of the

- current National Oceanic and Atmospheric Administration as well as the ocean minerals, marine mammal, and seabird programs of the Department of the Interior;
- Chesapeake Bay Program and the National Estuaries Program of the Environmental Protection Agency;
- aquaculture programs for marine species from the Department of Agriculture;
- shoreline protection and estuarine restoration activities of the Army Corps of Engineers.

The national oceans agency will be responsible for ensuring compliance with the National Ocean Policy Act, chairing the regional ocean ecosystem councils, providing technical and financial assistance to the councils, and reviewing and approving regional ocean governance plans.

5. Establish a permanent interagency oceans council.

Congress should enact legislation establishing a permanent national ocean policy council within the Executive Office of the President. The head of the national oceans agency should chair the national council. Its membership should be specified by law to include the heads of federal departments or agencies whose activities have a significant effect on the oceans. Council duties would include coordinating and overseeing agency implementation of the National Ocean Policy Act, resolving interagency disputes regarding NOPA implementation, and coordinating and certifying agency ocean budgets to address the national ocean policy. To assist the President and the national ocean policy council in carrying out NOPA, a position of national oceans adviser should be established within the Executive Office of the President.

Chapter Three
RESTORING AMERICA'S FISHERIES

Lobster buoys in York, Maine
Deb Antonini/Pew Oceans Commission

From *Moby Dick* to *The Perfect Storm*, the drama and the lore of fishermen's lives is embedded in America's consciousness, and its place is well deserved. Fishing is our oldest industry and has been a way of life since Native Americans first lived along our prolific coasts. The fishermen's heritage has enriched the social, cultural, and economic life of our nation.

Fishing figures prominently in both the national and regional economies. Commercial fishing is a multibillion-dollar industry tightly connected to the global economy. In 2001, the domestic commercial seafood industry contributed 28.6 billion dollars to the U.S. gross national product and American consumers ate an average of 15.2 pounds of seafood per person (NMFS, 2002a). Fishing is the number one employer in Alaska, which typically commands close to half the total annual U.S. commercial fish landings. Around the coasts, fishing is the backbone of the economy and culture for many coastal communities.

Fishing-related activities grease the engine of coastal tourism. Recent estimates indicate more than 17 million marine recreational fishers spend approximately 25 billion dollars per year on fishing-related activities and products (NRC, 1998). Recreational fishing is important to the economies of California and the South Atlantic and Gulf coast regions, particularly Florida.

Across the country, the Commission heard as well about a broader public interest in wild fish populations. Just as bird-watchers and hikers value land-based wildlife, divers, snorkelers, and whale-watchers are passionate about oceanic wildlife. These nature lovers are the heart of a large and growing marine ecotourism industry.

Master, I marvel how the fishes live in the sea.
Why, as men do a-land: the great ones
eat up the little ones.

William Shakespeare
Pericles, Act 2, Scene 1

The multidimensional uses of our marine wildlife reveal a national public interest in maintaining healthy marine ecosystems.

THE NATURE OF THE PROBLEM

Many of those ecosystems and the fishing heritage they support are now at risk. As Theodore Roosevelt IV told the Commission (Roosevelt, 2001), "We may be seeing the last great buffalo hunt taking place on the world's seas."

The principal problem is that we catch too many fish, and far too quickly, for nature to replace. Currently, we know of 93 U.S. fish populations that are already overfished or that are currently being fished at unsustainable rates—nearly a third of the 304 fish populations that scientists have assessed (NMFS, 2002b). The majority of the already overfished populations are still being fished unsustainably, frustrating rebuilding efforts. The status of another 655 populations, including 120 major stocks (those with landings of at least 200,000 pounds of fish a year) is unknown (Dayton et

al., 2002), and new assessments are expected to show even more overfished populations in need of rebuilding (NMFS, 1999; Figure One).

In addition to overfishing, wasteful bycatch, the destruction of fish habitat, and fishing-induced changes in marine food webs are diminishing the ocean's biodiversity and altering marine ecosystems. Marine animals currently considered at risk of extinction include northern right whales, the Hawaiian monk seal, the Pacific leatherback turtle, several species of California abalone, and about 82 marine fish populations in North America, including Atlantic salmon, bocaccio, and barndoor skate (Dayton et al., 2002).

Fishing has contributed to large changes in coral-reef ecosystems in the Caribbean, and to significant changes in community structure in the ecosystems of the Bering Sea off Alaska, Georges Bank off New England, Chesapeake Bay, and elsewhere (NRC, 1999). The tragic irony is that the benefits we so value from our fisheries depend on the very biodiversity and ecosystem productivity that unsustainable fishing practices threaten.

A PATTERN OF OVERFISHING

In September 2002, West Coast fishermen faced a new reality when they learned that severe restrictions would be placed on bottom fishing on much of the continental shelf from Canada to Mexico. The Pacific Fishery Management Council implemented the strictest regulations in the history of West Coast fishing in a final-hour attempt to save rockfish.

The status of four rockfish species drove the decision: bocaccio, canary rockfish, dark-blotched rockfish, and yelloweye rockfish. Bocaccio and canary rockfish are less than 10 percent of their historic numbers. Commonly sold in restaurants as Pacific red snapper, bocaccio was once the dominant rockfish species caught by commercial trawl fishers on the West Coast. At the height of the fishery in the late 1970s, more than 11,000 metric tons of bocaccio were landed a year. By 2001, the catch had dropped to 214 metric tons. The 2002 stock assessment recommends a catch of 0 to 20 metric tons (MacCall and He, 2002). Biologists predict it will take 90 years or more for the stock to recover if all fishing for bocaccio is halted, including those caught accidentally.

Even before the closure, the Secretary of Commerce had declared the West Coast groundfish fishery a "disaster," leading Congress to appropriate 5 million dollars for assistance. Now the livelihoods of an estimated 1,200 to 1,800 commercial fishing-boat operators are in jeopardy. An untold number of recreational fishermen and charter boat operations will also be affected.

The West Coast rockfish collapse is reminiscent of earlier disasters: the collapses of California's Monterey-based sardine fishery and New England's cod population, both of which are still struggling to recover. And prior to the cod debacle, Atlantic halibut were so heavily overfished in the 19th century that they have never recovered. Once thought impossible, we now know that we can push marine fish to the edge of extinction (Musick et al., 2000).

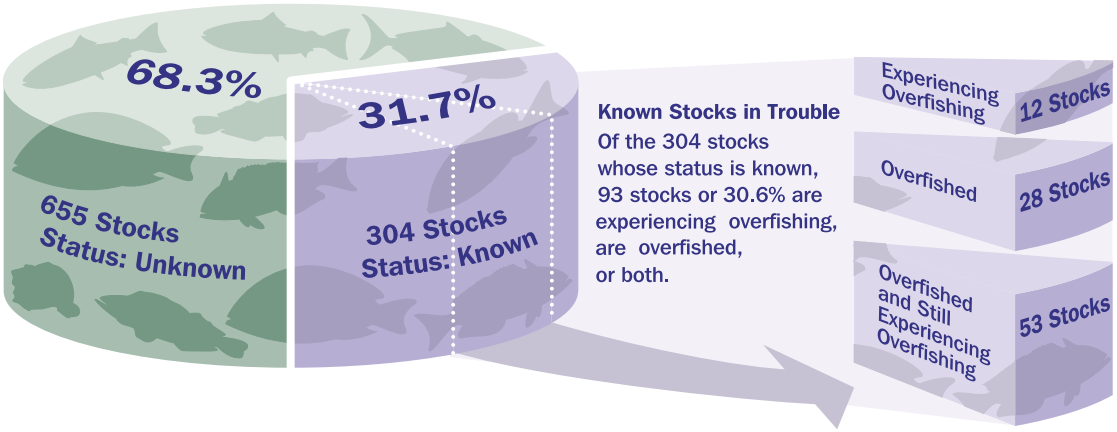
Of course, not every fishery ends in collapse. Although no region is immune to problems, fisheries have generally fared better in Alaska, which takes a more conservative

FIG. ONE

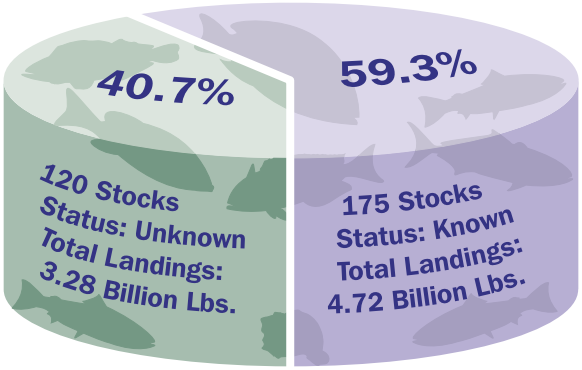
Status of Marine Fish Stocks

The U.S. Department of Commerce listed 959 stocks in its 2001 Annual Report to Congress on the Status of U.S. Fisheries. The data in the pie charts below are drawn from information in the annual report.

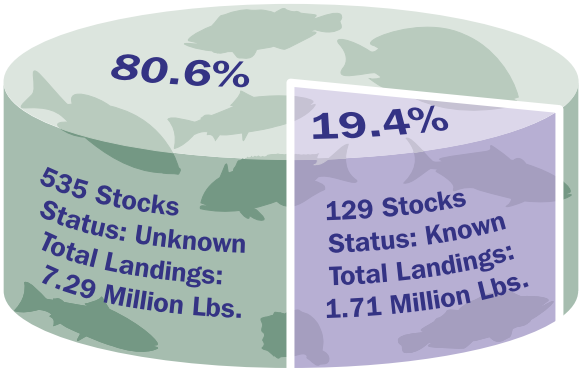
A. Status for 959 Stocks in 2001



B. Status for 295 Major Stocks* in 2001



C. Status for 664 Minor Stocks in 2001



*Major stocks are those with landings of at least 200,000 pounds. In 2001, 295 major stocks produced the majority of landings, totaling more than 8 billion pounds, compared with 9 million pounds from 664 minor stocks.

Lucidity Information Design, LLC

BOX ONE

Steve Simonsen/Marine Scenes

FISHING WITHOUT A PLAN: THE DOWNWARD SPIRAL OF THE SPINY DOGFISH

A small shark known as spiny dogfish is one of the most recent victims of unregulated fishing. Netted and hooked in New England waters and off the mid-Atlantic coast, most of the dogfish catch is exported to Great Britain for fish and chips. Slow to reach sexual maturity, dogfish are very susceptible to overfishing.

For 10 years, the fishery operated without a Fishery Management Plan. Between 1987 and 1996, commercial fishing for spiny dogfish had increased catches nearly tenfold and recreational fishing increased threefold. Because the industry targets females (they grow faster than males), the female population had fallen 80 percent by 2000. Scientists realized that the stock and the 8-million-dollar fishery it supported were in imminent danger of collapse. It took another two years before the Secretary of Commerce implemented a plan to establish a significantly reduced fishing quota and begin rebuilding the overfished stock.

Alaska, California, and Maine—along with several countries worldwide—have adopted emerging fishery policies to prevent fisheries from operating without management plans (see emerging fishery recommendation on pages 110–111 in Chapter 11).

approach to fishing. For federal fisheries off Alaska, a planning team of scientists recommends acceptable catch levels to a Scientific and Statistical Committee, which reviews them and makes recommendations to the fishery management council. The council allocates this allowable catch among the fishery participants, and it has very rarely raised a catch level above the scientists' advice.

The San Francisco Bay herring fishery and the International Pacific Halibut Commission are also frequently noted as more successful management models. Unfortunately, experience reveals these examples are the exception rather than the rule. All too often, it is not until overfishing has occurred that effective constraints on fishing are applied or, in some cases, that management plans are implemented at all (Box One).

In some cases, strict management and favorable circumstances can allow fish populations to recover from overfishing. The recovery of Atlantic striped bass demonstrates what can be achieved through aggressive single-species management techniques. Bottom trawl closures to protect high-relief living habitat essential for juvenile red king crab were instrumental in the 1990s recovery of the red king crab fishery in Bristol Bay, Alaska (Ackley and Witherell, 1999). More recently, due to aggressive efforts in New England, cod stocks are starting to show signs of rebuilding. Strict catch limits and other measures are allowing summer flounder and scup to recover off the mid-Atlantic states.

Though the occasional recovery offers hope, the Commission is convinced that we must prevent overfishing in the first place. Scientists at a Commission workshop in Seattle described new studies that suggest fish populations are less resilient than once believed and that recovery of depleted populations may take longer than expected (Figure Two). One study analyzed 90 populations that declined 13 to

99 percent over a 15-year period. Fifteen years after these initial declines, 12 percent of the populations for which data was available had recovered but 40 percent had experienced no recovery at all. All of the species that had fully recovered were fish that mature quickly, such as herring and sprat. Prized fish, such as cod and haddock, had not recovered (Hutchings, 2000).

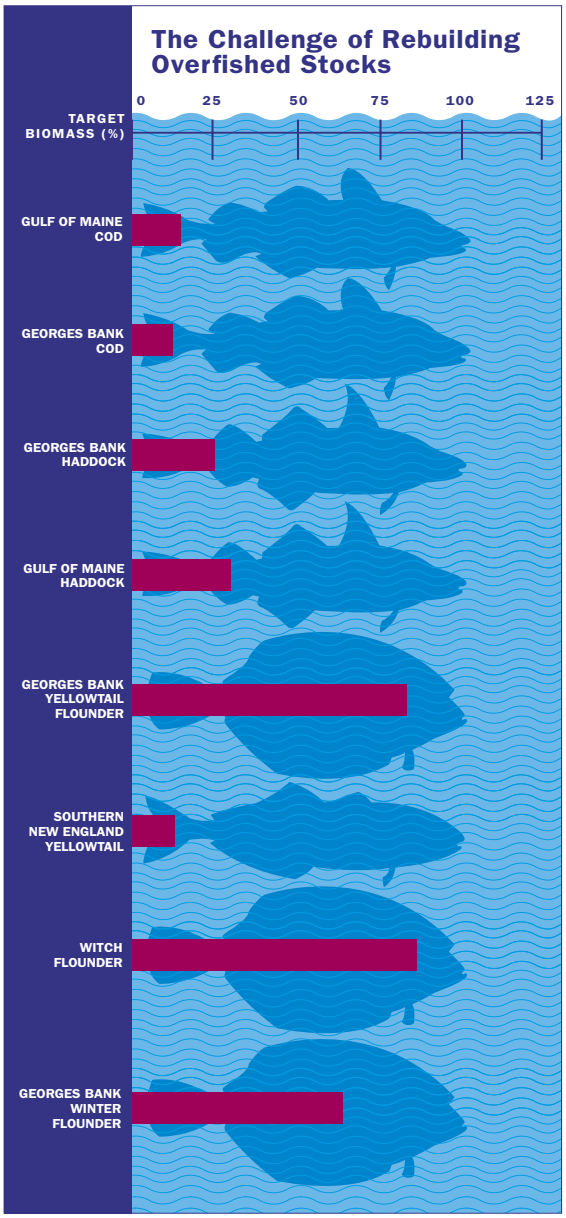
EXCESS FLEET CAPACITY

The Bering Sea crab fleet now numbers around 250 boats, and many believe the fleet has up to five times the fishing power needed to catch available crabs. As far back as 1991, overcapacity had shortened the fishing season for Bering Sea red king crab into a dangerous seven-day scramble. Managers can have a difficult time assuring that catches stay within safe limits under these circumstances.

This type of fishing fleet overcapacity often goes hand in hand with overfishing. But the situation is not merely one of "too many boats chasing too few fish." Excess fish-catching capacity, or fishing power, is a combined result of the number of boats, their size, and their enhanced technology.

New technology has made it hard for fish to hide and has vastly increased fishing efficiency. Geographic information systems and other computer technology have increased our ability to locate schools of fish we previously could not "see." Boats today have larger, stronger, and heavier gear capable of fishing in previously inaccessible areas. New rockhopper gear and bigger roller gear allow bottom trawl nets to hop, roll over, and crush complex bottom habitat where previously gear would snag and become damaged or lost. Our technology

FIG. TWO



Art: John Michael Yanson

Once abundant off New England's coast, many groundfish have been depleted and have only recently begun to rebuild under aggressive conservation measures. Though their populations are on the rise, many have a long way to go before they recover. The famed Georges Bank cod population, for instance, is estimated to be less than a third of the size it was just 20 years ago. Most of the major New England groundfish stocks are currently below their target population levels, and many are far from approaching the population abundance (target biomass) that would support maximum sustainable yield.

Source: NEFSC, 2002.

Note: The eight species in this graph were selected from the NEFSC report because they are the principal species listed in the NMFS 2001 Annual Report to Congress on the Status of U.S. Fisheries and the species whose status is known.

is simply outstripping natural obstacles and the ability of fish to replenish.

Even where fish populations appear to be healthy, fleet overcapacity can weaken fishermen's social and economic situations. Accelerating competition for increasingly scarce resources produces chronic economic instability and lowers fishermen's net incomes. This can lead to severe conflict in the allocation process and continuous pressure to increase allowable catches. Excess fleet capacity can also generate a dangerous and environmentally damaging race for fish, which weakens regulatory efforts.

Because access to fisheries has largely been free and open and the government has subsidized the development of a domestic fishing fleet, the amount of capital and labor in many U.S. fisheries exceeds that needed to take ecologically sustainable catches and provide economically viable fishing operations for many fishermen. The economic system supporting fishermen is only as strong as the ecosystem supporting fish.

FISHING DOWN THE FOOD WEB

The decline of one fish population often triggers the development of fisheries for new species. Fishermen in New Hampshire told the Commission about how the government encouraged them to direct their fishing effort to new stocks such as spiny dogfish—previously considered a low-value "trash" fish—after highly prized cod, haddock, and yellowtail flounder stocks were overfished. Ten years of largely unregulated fishing then overfished spiny dogfish. Shifts to fishing new, usually low-valued species, such as spiny dogfish, as the high-valued stocks become depleted has propped up commercial fishery landings, masking the broader influence of fishing on marine ecosystems.

This serial overfishing is related to a phenomenon known as fishing down the food web. Large-bodied, top carnivore species such as tuna, swordfish, salmon, and many sharks, are prime targets for fisheries. Serious depletion of their populations is thought to destabilize the rest of marine food webs, and, thus, entire ecosystems. Further disruption is likely when depletion of these top carnivore species results in fishing down the food web (i.e., intense fishing pressure shifting to mid-trophic and finally low-trophic species). This phenomenon causes additional disruption as successively more and more of the ecological checks and balances in a system are removed.

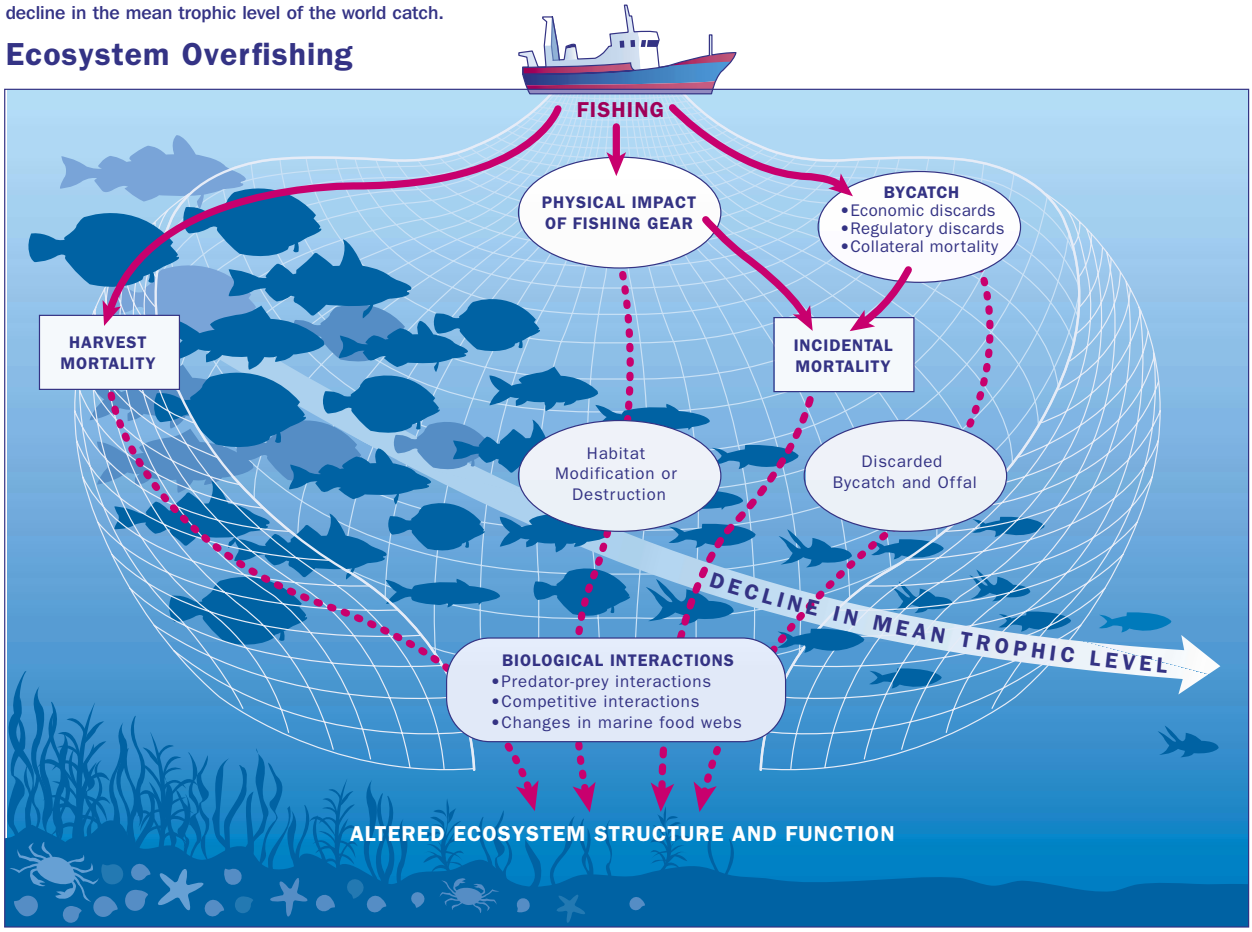
The consequences of this disruption can be severe. Diversified food webs with sufficient population sizes at all trophic levels allow predators to switch among prey as the abundance and mix of species in a system naturally fluctuates. Overfishing of top-trophic species and subsequently mid- and low-trophic species removes this natural benefit of biodiversity by gradually disrupting and truncating trophic relationships. This leads to unpredictable changes, such as increased disease outbreaks and the proliferation of previously suppressed pests and weedy species. Thus, fishing down the food web may hinder recovery of depleted populations even after recovery plans are in place (Pauly et al., 1998; Pauly et al., 2002).

Serial overfishing and fishing down the food web reduce the populations and sustain-

FIG. THREE

Fishing directly affects the abundance of marine fish populations (harvest mortality) as well as the age of maturity, size structure, sex ratio, and genetic makeup of those populations. Fishing affects marine biodiversity and ecosystems indirectly through bycatch, habitat degradation, and through biological interactions (incidental mortality). Through these unintended ecological consequences, fishing can contribute to altered ecosystem structure and function. As commercially valuable populations of fish decline, people begin fishing down the food web, which results in a decline in the mean trophic level of the world catch.

Ecosystem Overfishing



Art: John Michael Vanson

Source: Adapted from Pauly et al., 1998; Goñi, 2000.

ability of entire assemblages of fish populations—not just a few economically valuable populations. Together, they can cause major ecosystem disruption (Figure Three).

FISHING AND MARINE ECOSYSTEMS

Fishing affects marine wildlife other than targeted fish in a variety of ways. Humans share the oceans and the fish with marine mammals, seabirds, and other wildlife. We can often outcompete these animals for the same fish. Scientists attending the Commission's fishery management workshop in Seattle, Washington, reported that these types of competitive interactions are poorly accounted for in current management regimes (POC, 2002).

At the Commission's public hearing in Alaska, citizens described how litigation drove changes in management to reduce the potential for competition between fisheries and Steller sea lions. Similar situations exist elsewhere. In

New York, the Commission heard how public pressure drove changes in the mid-Atlantic horseshoe crab fishery to ensure that migrating shorebirds would have enough horseshoe crab eggs to consume.

Because U.S. fisheries depend on wild fish populations, they also rely on productive and resilient ecosystems to support those populations. All marine wildlife has evolved and adapted to coexist with competitors, as prey and predators in functioning ecological communities. To thrive, wildlife also needs healthy habitat for living space and adequate food resources on which to subsist and raise young.

HABITAT DEGRADATION AND ALTERATION

From rain forests to the Florida Everglades, people are generally aware of the danger that habitat loss poses to wildlife on land, where it is a leading cause of extinction. Habitat loss is also a danger in the seas.

Fishing gears such as bottom trawls and dredges can damage the physical structure of marine habitats as they scrape or plough the seafloor. Three-dimensional structures built up over centuries can be crumpled with the swipe of a dredge. Sponge reefs, oyster beds, and coral colonies—living reefs as well as forests of fossilized coral—are vulnerable. So, too, are boulder fields and seamounts that provide shelter for juvenile fish. Even the ocean sediment, with its complex communities of burrowing fish, worms, and other invertebrates, can be altered in ways that affect marine ecosystems.

As the Commission heard from a number of scientists, mechanized harvesting that reduces habitat complexity can change species composition, abundance, diversity, and the productivity of associated marine life (NRC, 2002; Auster, 2001; Watling, 2001). Destruction of bottom habitat features used by adults for foraging or spawning may also hinder recovery of overfished populations (Koenig et al., 2000).

The total extent of habitat destruction by fishing gear is unknown. However, we do know its extent is far greater and it occurs more frequently than do most natural disturbances (reviewed in Dayton et al., 2002). A typical section of northern California's seafloor is trawled an average of one and a half times per year with other areas trawled as often as three times per year. Areas of New England's Georges Bank are trawled three to four times per year. Adverse effects caused by these practices can be both chronic and cumulative, leading to reductions in biodiversity with potentially broad adverse effects on ecosystem function (reviewed in Dayton et al., 2002).

BYCATCH

Bycatch also takes a toll on marine life and ecosystems when fishermen accidentally catch, injure, and kill marine life they do not intend or want to capture. Scientists estimate that fishermen discard about 25 percent of what they catch worldwide (reviewed in Dayton et al., 2002; Figure Four). If the same discard rate occurs in U.S. fisheries, some 2.3 billion pounds of marine wildlife would have been tossed—injured or dead—back into the oceans in 2000. Leading experts say that bycatch is one of the most significant environmental and economic problems affecting marine fisheries today (Hall et al., 2001; Hall, 1999).

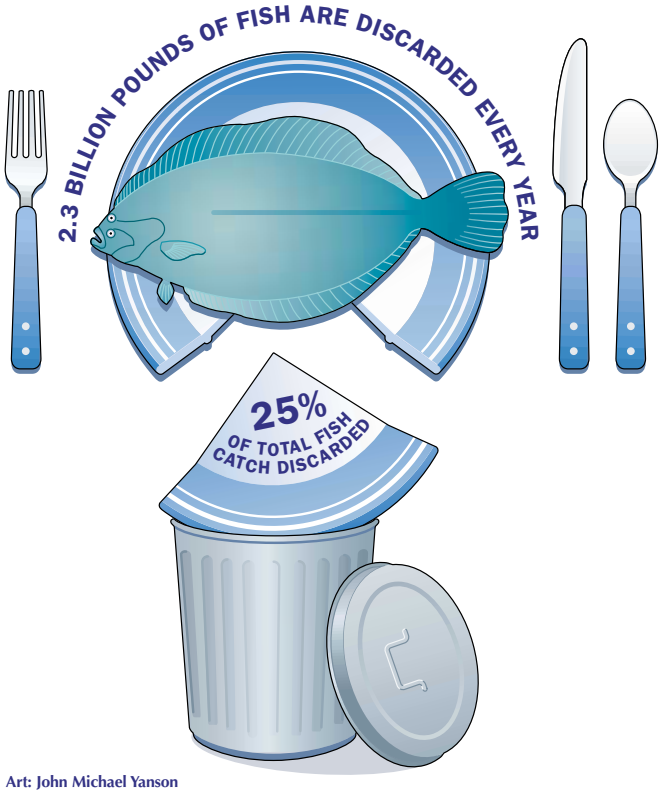
Bycatch contributes to overfishing, prolongs population recovery, and contributes to conflict among user groups. As Chris Dorsett, formerly with the Gulf Restoration Network, explains, "Two of the most valuable fisheries in the Gulf are always at each other's throats because shrimp trawls catch too many juvenile red snapper as bycatch. We could stop all directed catches of red snapper tomorrow and they still wouldn't bounce back in the near future unless juvenile mortality from shrimp trawling is reduced significantly." The Commission's investigation led it to conclude that marine fisheries will remain on the treadmill of overexploitation until bycatch is effectively limited.

Bycatch is also a serious concern for noncommercial marine wildlife. Dramatic declines of leatherback sea turtles, blue marlin, smalltooth sawfish, and the barndoor skate suggest that, in extreme cases, bycatch may be the leading reason a species is in jeopardy (reviewed in Dayton et al., 2002). Bycatch poses the most significant threat to U.S. sea turtle populations, all six of which are either threatened or endangered (Hall, 1999; NRC, 1990). It has also seriously depleted a number of marine mammal populations, such as dolphins in the eastern tropical Pacific Ocean, and concern about its impact on seabirds is increasing. Most harmful to seabirds are the effect of longline bycatch on albatrosses, petrels, and shearwaters and the effect of gill nets on shearwaters and auks (reviewed in Dayton et al., 2002)

Together, the unintended consequences of overfishing, bycatch, and habitat degradation can alter the very biodiversity, productivity, and resilience of marine ecosystems on which economically valuable species and fisheries depend. Breaking the cycle of overfishing requires a shift in perspective and management techniques. Sustainable management of wild capture fisheries will require incorporating and applying ecosystem principles in fishery management (Box Two, page 44).

FIG. FOUR

Bycatch



Art: John Michael Yanson

Bycatch is the incidental catching, discarding, or damaging of living marine resources when fishing for targeted species. Though there is no comprehensive estimate of bycatch in U.S. marine fisheries, globally it is estimated that 60 billion pounds of unwanted fish were discarded each year during the 1980s and early to mid-1990s—representing 25 percent of the world's catch. If that rate occurs in U.S. fisheries, then the total landings of 9.1 billion pounds in 2000 would have been accompanied by about 2.3 billion pounds of discards (with a range of 1.7 billion to 3.3 billion pounds). Because discards represent only a portion of the total bycatch, the total amount of life accidentally captured and killed in fishing operations could exceed these discard estimates. Bycatch is a major factor in the significant decline of many marine mammal populations, most species of sea turtles, several species of albatross, and several skates and rays.

Source: Dayton et al., 2002.

BOX TWO

Steve Simonsen/Marine Scenes

ECOSYSTEM-BASED FISHERY MANAGEMENT

The need to shift to ecosystem-based management has become a common mantra within the last five years (NRC, 1998), and it is often misunderstood. Ecosystem-based management does not require that we know everything about marine ecosystems or the effects of fishing upon those systems. It also does not require that we know much more than we currently do, at least to start. Nor does it mean a wholesale and immediate abandoning of all single-species management techniques.

Ecosystem-based management entails developing a new perspective that acknowledges and understands that

- there are limits to our knowledge;
- marine ecosystems are inherently unpredictable;
- ecosystems have functional, historical, and evolutionary limits that constrain human exploitation;
- there is a fundamental trade-off in fishing that must be balanced between fish for human consumption and fish for the rest of the ecosystem;
- ecosystems are complex, adaptive systems.

Ecosystem-based management requires that we reconsider what is meant by "overfishing." We need to get away from traditional, problematic maximum sustainable yield and surplus-production models to consider the level of fishing that has detrimental effects in the ecosystem, even though it may not have an adverse effect on a particular target species (Murawski, 2000). Flexible, adaptive management that incorporates new knowledge and provides some level of insurance for unpredictable and uncontrollable events embodies ecosystem-based management. However, ecosystem-based management is not a substitute for single-species management. Instead, it should be implemented to augment the best of single-species management techniques.

FRAYED NET OF GOVERNANCE

In many ways, the crisis in marine fishery management is a crisis of governance. The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) provides the broadest articulation of American marine fisheries policy and the basis of some aspects of state and interstate fishery management regimes. Originally crafted in 1976, the law is based upon what we now understand to be outdated principles. Though the law was strengthened in 1996, underlying structural and systemic problems remain.

Three fundamental problems afflict the Magnuson-Stevens Act. First, its management regime emphasizes short-term commodity production, revenues, and employment rather than sustaining natural systems that support and enhance wild fish populations. Although authority to sustain fishery resources exists within the law, it has been overwhelmed by the drive to maximize catches. As a result, single-species management techniques, the desire for short-term profits over sustainable long-term income, and advances in technology have driven fishery conduct.

Second, the management structure and process suffer from regulatory capture, a state of affairs in which government regulators (in this case, fisheries managers) have come to believe that their role is to defend the interests of the regulated community rather than promote the public interest. Resource users—principally commercial interests—drive

management decisions. They exercise power through eight regional fishery management councils that were originally established to assure that management would be tailored to regional differences and local needs. In practice, resource users dominate the councils' voting memberships.

The law establishes the councils as the lead managers to formulate fishery-management policy applicable to their region. In practice, councils make both conservation (How much should be caught?) and allocation (Who gets to catch it?) decisions. This often leads to short-term allocation considerations overriding long-term conservation imperatives needed to ensure a sustainable fishery. Thus, councils avoid making tough decisions about limiting who can fish and how much they can catch.

The Commission's investigation has identified no other publicly owned American natural resource managed through a process that allows resource users to decide how much of the public resource can be taken for private benefit. In the majority of fisheries examined by the Commission, this system has created nearly insurmountable obstacles to managing the resource for sustainable catches and for the broad public benefit over the long term.

Third, the law codified an open access, *laissez-faire* approach. This fosters a reactive management philosophy that focuses more on day-to-day fishing needs than on restoring and maintaining sustainable resources for the future. The emphasis on producing commercial commodities overwhelms the kind of management that would more effectively limit the taking of commercial species and protect noncommercial species and critical habitats. The current system also relies on scientific uncertainty to justify risk-prone decisions (Rosenberg et al., 1993; Hanna, 1998). Fishery after fishery has foundered on the shoals of this approach.

Today, productive ecosystems, and the fishing industries and communities that depend upon those ecosystems, are in a dangerous state of decline. Increased scientific understanding has revealed that fishing can profoundly affect biodiversity and marine ecosystems. This knowledge is shifting societal attitudes about exploitation of living marine resources. An adjustment in the principles, laws, and institutions governing marine fisheries is required to reflect the needs and understanding of this new era.

Ron Niebrugge/wildnatureimages.com

The oceans provide many benefits that cannot be easily measured, such as time spent between a parent and a child.

TOWARD REFORM

As conservation needs have become more apparent, the government has taken steps to reform the law and its implementation. The Sustainable Fisheries Act of 1996 (SFA) amended the Magnuson-Stevens Act, requiring actions to stop overfishing, rebuild depleted populations, minimize bycatch, and protect habitat from harmful fishing gear while minimizing economic harm to fishing communities. However, the reforms neither clarified ambiguous, outdated management objectives nor lessened or removed the problem of regulatory capture. They also left in place the open access, *laissez-faire* management presumption. Many of the reforms that were passed have not yet been implemented, seven years after the fact.

Dave Bjorn/Photo Resource Hawaii

An estimated 17 million marine recreational fishermen across America, including these in Hawaii, depend on fish for subsistence and recreation. Altogether, they spend approximately 25 billion dollars per year on fishing-related activities and products (NRC, 1998).

The limited success of the SFA underscores the need for more far-reaching reform. The fact that restoring ecosystems and fish populations could create tens of thousands of family-wage jobs and substantially boost our coastal economy suggests such reform is well worth the effort. The National Marine Fisheries Service (NMFS) estimates that the nation could increase fish catches by 64 percent above recent yields—or an additional 6.9 billion pounds per year—by restoring populations and natural systems. These increased annual catches could add at least 1.3 billion dollars to the U.S. economy (McCallum, pers. comm.). If we want marine fish populations to continue to provide the ecological, social, cultural, and economic benefits we cherish, the U.S. must chart a clearer course, reorder institutions, and change the underlying incentives to protect biodiversity and marine ecosystems.

SUMMARY OF RECOMMENDATIONS

Congress should amend the Magnuson-Stevens Act and other applicable fisheries laws to codify the following recommendations as national marine fishery policy:

1. Redefine the principal objective of American marine fishery policy to protect, maintain, and restore marine ecosystems. The principal objective of fishery management should be to protect the long-term health and viability of fisheries by protecting, maintaining, and restoring the health, integrity, productive capacity, and resilience of the marine ecosystems upon which they depend. The objective should apply to all U.S. ocean

waters. In cases of conflict between this objective and short-term social or economic needs, or in cases where information is uncertain or inconclusive, the need to protect, maintain, and restore these features of marine ecosystems should always be the top priority.

2. Separate conservation and allocation decisions.
There should be a clear separation between conservation and allocation decisions in the fishery-management planning process. The purpose of this change is to assure that ecological sustainability takes precedence over short-term economic or political considerations. Conservation and allocation decisions are discrete processes that require different management skills and different types of decision-making organizations. Conservation decisions should be made by NMFS, or a revamped fishery service within a new national oceans agency. They should be based upon recommendations from regional science and technical teams composed of federal, state, and academic scientists. Conservation decisions should precede and remain unchanged by allocation decisions, with one exception: allocation decision-makers may adopt more conservative policies than those set in the conservation planning process. Regional fishery councils should take the lead on allocation decisions subject to final approval by NMFS.

3. Implement ecosystem-based planning and marine zoning.
Fishing should not proceed in the absence of an approved plan. Core problems in existing fisheries, such as bycatch and habitat damage, must be managed and mitigated as a condition of fishing. Before fishing begins, the government should determine where and when the fishing shall occur, how much exploitation is acceptable, and how the fishing should be conducted. The government should make these decisions only after considering how the entire ecosystem that supports the fishery—not just the target species—will be affected by fishing. For new fisheries, this requires enactment of an emerging fisheries policy. Plan implementation should incorporate comprehensive zoning to partition planned areas into sections designated for specific uses.

4. Regulate the use of fishing gear that is destructive to marine habitats.
Fishing gear should be approved for use subject to a zoning program. The program should designate specific areas for bottom trawling and dredging if scientific information indicates that these activities can be conducted without altering or destroying a significant amount of habitat or without reducing biodiversity. Zones not designated suitable for these purposes should be closed to bottom trawling and dredging. Sensitive habitats as well as areas not currently trawled or dredged should be closed to such use immediately. Gear modification and conversion programs, with funding provisions, should accompany the new zoning regime. Funding should also be provided for research into possible ways to reduce habitat impacts of bottom trawls and dredge gear.

5. Require bycatch monitoring and management plans as a condition of fishing. Bycatch monitoring and minimization plans should be approved before the commencement of fishing. The statutory goal of these plans should be to reduce bycatch to levels approaching zero. Individual bycatch quotas for valuable fish species (except threatened and endangered species) appear to provide the most rational approach to managing toward that goal. Conservative catch quotas should be set for species, accounting for intended and unintended catch. Fishermen should be allowed to keep fish they catch within conservative limits, rather than being forced to discard and waste one species because they are in a target fishery for another. A plan should be developed for each fishery, using a stakeholder process modeled on the Marine Mammal Protection Act Take Reduction Teams that is subject to statutory standards.

A sea turtle is caught in a trawl net off the coast of Florida. Although steps have been taken to reduce mortality in the shrimp fishery, accidental capture in fishing operations remains the most significant threat to U.S. sea turtle populations.

6. Require comprehensive access and allocation planning as a condition of fishing. Regional fishery councils should develop allocation plans, before the commencement of fishing, that limit access and allocate catch in a manner consistent with conservation goals. At a minimum, each plan should: (1) help match the size of fishing fleets and their catching capacity to the health of exploited populations and their ecosystems; (2) manage fishing effort with privileges, such as total allowable catches, that control exploitation of fish populations within ecologically safe limits; and (3) allocate privileges in a manner that properly aligns incentives, allows for the orderly operation of a fishery (e.g., individual or community fishing-quota programs), and maintains flexibility, resilience, and adaptability within the industry and fishing communities.

7. Establish a permanent fishery conservation and management trust fund. A permanent trust fund for marine fisheries should be available, without appropriation or fiscal year limitation, solely for the purposes of improving fishery research, data collection, management, and enforcement; for habitat restoration; and—in the first 5 to 10 years of operation—for transitional buyback and community-development programs. Potential revenue sources include revenues generated by royalty payments on landed catch (e.g., royalty payments collected as part of an individual or community fishing quota auction process) and fees collected from fines and other penalties.

Chapter Four
PRESERVING OUR COASTS

Miami Beach, Florida
Cameron Davidson/Stock Connection

THE NATURE OF THE PROBLEM

Throughout history, the coast—the place where land and rivers meet the sea—has been an area of astounding biological abundance. Diverse and unique habitats and abundant fish and other wildlife have graced our coasts. Even Americans who live far inland reap the coasts' benefits when they dine on succulent saltwater fish or visit the ocean shores.

In the United States today, our coasts are deceptive in their beauty. Surface appearances mask a crisis that extends from upper watersheds to depleted offshore coral reefs. The problem, simply put, is that we are loving our coasts to death.

Today, more than half the population of the United States lives in coastal counties. Yet, these counties comprise just 17 percent of the nation's land area. As a result, population density along the coasts is about five times the national average. The latest census data indicate that this population will increase by another 20 percent by 2015 (Beach, 2002), as some 3,600 people move to the coasts each day.

In Louisiana, the issue is not whether we live on the coast. In a sense, everyone lives on the coast. For hundreds of years, we all have lived and worked on the fingers of rivers and bayous. In between those waterways has been the natural protection of swamp and marsh. The loss of this marsh will incrementally destroy the economy, culture, ecology, and infrastructure of this state and this region.

King Milling, President, Whitney National Bank
An excerpt from Mr. Milling's testimony at the Pew Oceans Commission Public Hearing, New Orleans, Louisiana, March 15, 2002

Permanent residents are not the only source of pressure on coastal ecosystems, for the beach is a favorite destination. Tourism is the second largest contributor to the U.S. gross domestic product and coastal tourism and recreation account for 85 percent of all tourism revenue (NOAA, 1999). In California alone, coastal tourism is valued at nearly 10 billion dollars annually, far exceeding the 6 billion dollars generated

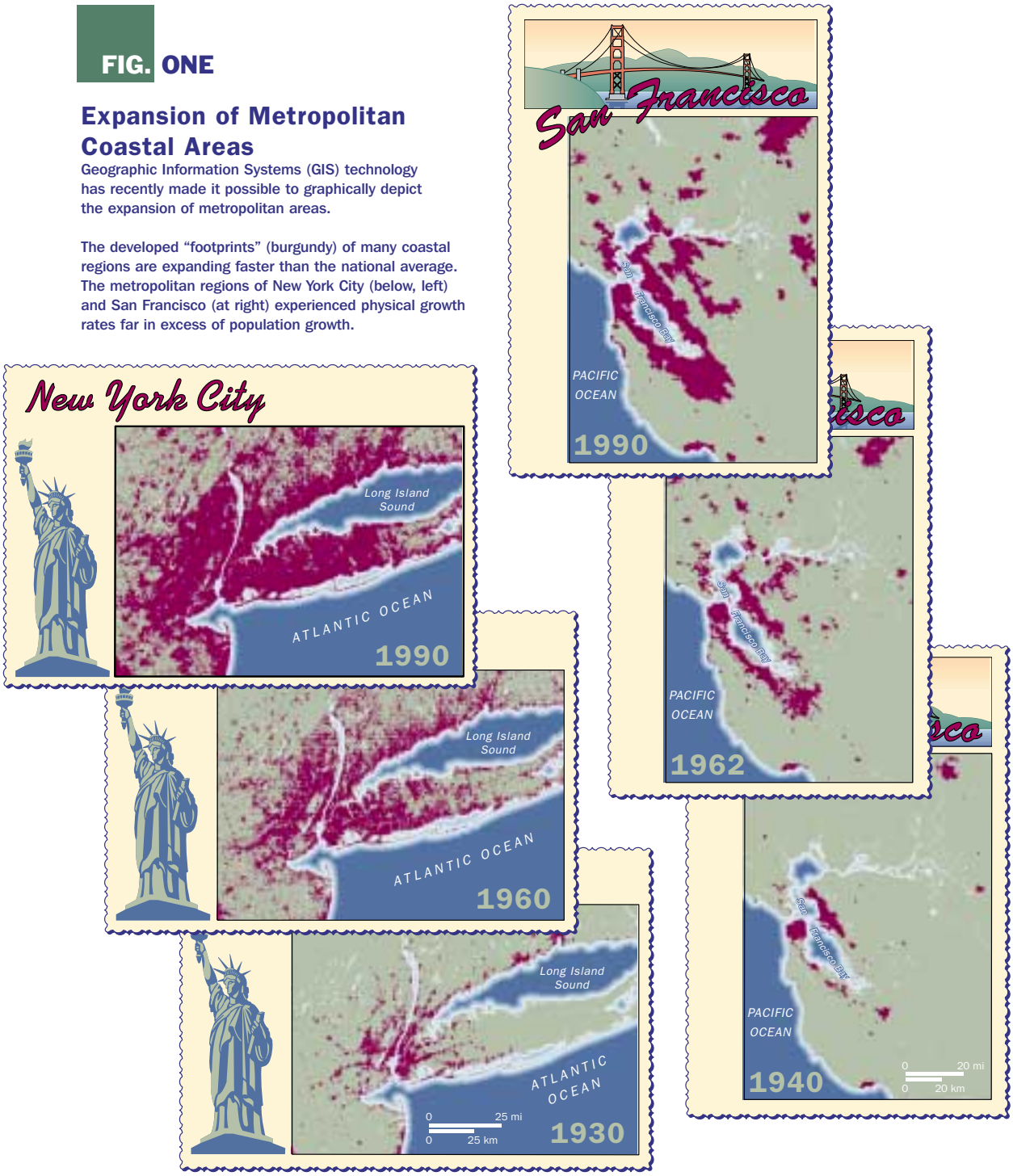
Coastal tourism and recreation account for 85 percent of all tourism revenue, which is the second largest contributor to the U.S. gross domestic product. Yet, the infrastructure and services required to accommodate tourism can damage the environment that attracts visitors to the nation's coasts.

FIG. ONE

Expansion of Metropolitan Coastal Areas

Geographic Information Systems (GIS) technology has recently made it possible to graphically depict the expansion of metropolitan areas.

The developed "footprints" (burgundy) of many coastal regions are expanding faster than the national average. The metropolitan regions of New York City (below, left) and San Francisco (at right) experienced physical growth rates far in excess of population growth.



Sources: NOAA, 2002; Map images for New York adapted from maps created by Craig Campbell, using data provided by a partnership of Regional Plan Association, the United States Geological Survey, and Cornell University. Source for San Francisco map images: United States Geological Survey.

Art: John Michael Yanson
Maps: Jerome N. Cookson

by port traffic and dwarfing the 550 million dollars generated by the state's fisheries and mariculture, or saltwater aquaculture (Wilson and Wheeler, 1997).

With these throngs comes new development, which increases demand for housing, water, food, recreation, waste disposal, roads, and cars. All of this is polluting the water and air and endangering coastal habitats.

Habitat destruction and the decline of coastal water quality are the primary threats to species with which we share the coastal environment. Those threatened include many ecologically and economically important species, as well as rare and unique habitats. Urban sprawl, for example, contributed to the decline of 188 of the 286 California species that are listed under the Endangered Species Act, making it the leading cause of species decline in that state (Doyle et al., 2001).

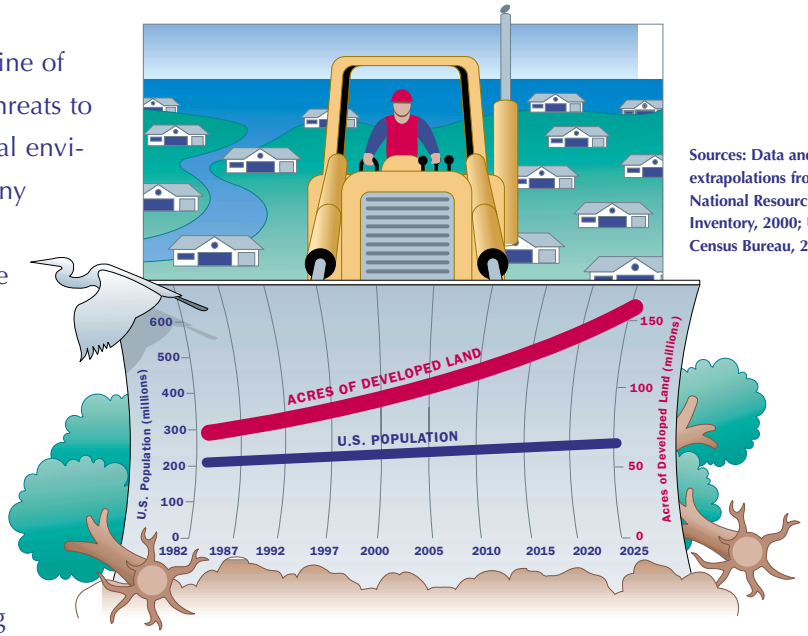
We are fundamentally changing the natural ecosystems that attract us to the coasts. In some areas, we have converted expansive wetlands into cities, protected on all sides by levees. In others, we have converted sand dunes into irrigated golf courses and subdivisions.

The problem is not just one of population; our patterns of land use amplify the effects of population growth on coastal ecosystems. In addition, government agencies and programs have engaged in environmentally harmful development in coastal watersheds for decades.

FIG. TWO

The Rate of Land Development and the Rate of Population Growth

Land in the United States has been developed at more than twice the rate of population growth since 1982. This increase is a result of a consistent decline in development densities over the past few decades. If this trend continues through the year 2025, the nation will consume another 68 million acres of rural land—an area the size of the state of Wyoming. The total developed land in the United States will reach 174 million acres by 2025—an area larger than the state of Texas.



Sources: Data and extrapolations from National Resources Inventory, 2000; U.S. Census Bureau, 2000.

Art: John Michael Yanson

The population explosion on our coasts will continue. It is up to us to manage that development in ways that protect coastal ecosystems. If not, we will find ourselves impoverished, along with our coasts.

CHANGING LAND USE PATTERNS

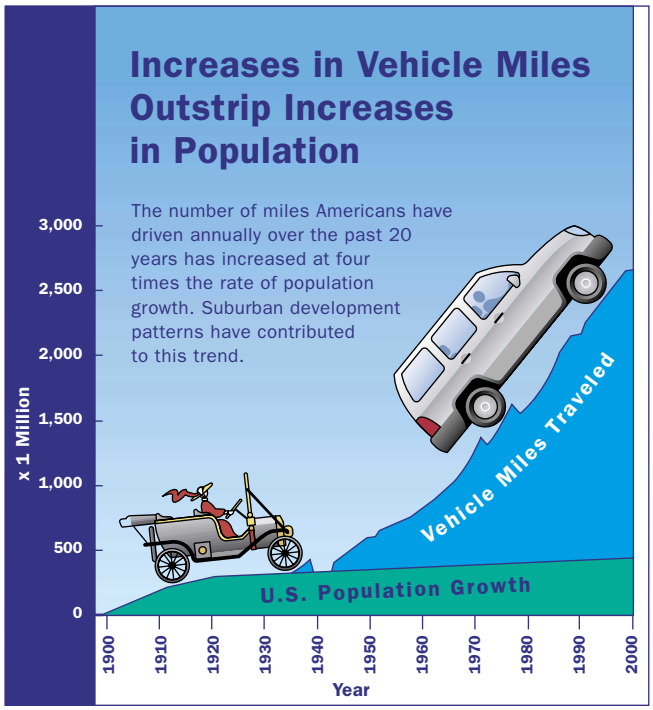
In the decades following World War II, Americans fled crowded inner cities in record numbers. Between 1950 and 1990, the urban population of the United States grew by about 15 percent and the rural population decreased

slightly, while the suburban population more than tripled (Diamond and Noonan, 1996). During this period, affordable automobiles, cheap gasoline, and a rapidly expanding and heavily subsidized road system allowed—for the first time—large numbers of people to live miles from where they worked.

In many ways, the coasts led these changes. Coastal development extends from the floodplains of rivers and estuaries to barrier islands. Fourteen of the nation's 20 largest cities and 19 of the 20 most densely populated counties lie along the coast. Furthermore, the rate of land consumption in many of these major metropolitan areas is four or more times the population growth rate (Figure One, page 50). If nationwide land development trends continue, by 2025 we can expect an additional 68 million acres—an area of land roughly the size of Wyoming—to be converted to residential and commercial use (Beach, 2002; Figure Two, page 51). Most of this growth will occur along our coasts.

Sprawl—low density, automobile-dependent development that separates residential areas from jobs, goods, and services—has become the predominant pattern of urban development in the United States. This approach to development is, by definition, inefficient in its use of land. The use of zoning ordinances to mandate large lot size and to separate residential development from commercial areas was intended to protect homeowners from the kind of crowding and pollution that originally drove people from the inner cities. But by spreading out development and separating residents from even the most

FIG. THREE



Art: John Michael Vanson

Source: Adapted from Beach, 2003. Compiled by Michelle Garland, Surface Transportation Policy Project; Federal Highway Administration, Office of Highway Information Management. Highway Statistics Summary to 1995; Federal Highway Administration, Office of Highway Information Management. Highway Statistics Series, 1995 to 1999; Federal Highway Administration, Office of Highway Information Management. Traffic Volume Trends, December 2000; United States Census Bureau. Historical National Population Estimates: July 1, 1900 to July 1, 1999; United States Census Bureau. Monthly Population Estimates, 1990 to 2000.

basic goods and services, sprawl gobbles up land and exacerbates traffic and pollution.

Since 1960, the number of vehicle miles traveled by Americans has more than tripled (NRDC, 2001; Figure Three). As a result, vehicle exhaust is contributing a growing share of the total air pollution. We now know that atmospheric deposition—air pollution that eventually settles down on land or water—is a major source of nitrogen pollution in our nation's waterways. This is particularly a problem along the Atlantic seaboard and in the

Cameron Davidson/Stock Connection

Intensive beachfront development destroys wildlife habitat, impairs water quality, and reduces the ability of barrier islands to protect the mainland from storms and flooding.

Mississippi River watershed, where high rainfall combines with air pollution to exacerbate atmospheric deposition (Puckett, 1994).

MISGUIDED GOVERNMENT PROGRAMS

Substantial growth in many American's personal wealth, combined with cheap flood insurance and a period of relatively few hurricanes, have contributed to billions of dollars worth of real estate development in high-risk and environmentally fragile coastal areas. Low-cost federal flood insurance has substantially reduced the financial risk of this development, and government-financed flood control, beach restoration, and shoreline hardening projects have created a false sense of security for residents in these low-lying areas.

Government projects have dramatically altered our rivers and coastal waterways. These often-massive efforts spur development while paying scant attention to environmental consequences. The economic benefits they have provided—particularly to agriculture and shipping—come at a high ecological price (Box One, page 54). Habitats, species, and whole ecosystems are threatened by the elimination of wetlands, the channelization and damming of rivers, and the stabilization of inherently unstable beaches and barrier islands.

These changes have not been random. The Army Corps of Engineers, established in 1779, is the nation's main water resources management agency. It is responsible for building and maintaining more than 1,500 federal water projects. These include the construction and maintenance of more than

BOX ONE

Steve Simonsen/Marine Scenes

DELTA BLUES

Louisiana is gripped by a major crisis brought on by decades of misguided development of our land and waters. Due to channels and levees constructed by the Army Corps of Engineers, the Mississippi itself now flows more like a ditch than a river, shunting fertilizers and pesticides downstream. One result is a low-oxygen dead zone in the Gulf of Mexico off the mouth of the Mississippi that can span more than 8,000 square miles of coastal ocean. The zone is caused by excess nutrients—mostly nitrogen—that drain into the ocean from agricultural lands along the Mississippi River. As they sink and decay on the bottom, algal blooms resulting from the excess nutrients drain oxygen from the Gulf waters.

The extensive channel and levee system along the Mississippi blocks sediments formerly supplied by floodwaters and exacerbate erosion and saltwater intrusion from the Gulf of Mexico. Navigation channels that crisscross the region also contribute to large-scale erosion of the delta. Thus, the delta has lost more than 1,000 square miles since 1950, and continues to lose 25 to 35 square miles per year. If current loss rates continue, more than 630,000 acres of Louisiana wetlands will be converted to open water by 2050.

The Commission heard testimony about this crisis at a public hearing in New Orleans. Following are excerpts from the testimony of King Milling, President of the Whitney National Bank, New Orleans, and chair of the governor-appointed Committee on the Future of Coastal Louisiana.

Louisiana, the Mississippi Delta, and the Gulf of Mexico, as reflected by the hypoxia problem, are all victims of national policy. I don't say this to assess blame. It's a fact. The channelization of the Mississippi River and its tributaries, not to mention the dredging of numerous navigational waterways, has created an impact that shall absolutely devastate south Louisiana and the lower delta.

The loss of Louisiana's marshes will incrementally destroy the economy, culture, ecology, and infrastructure, not to mention the corresponding tax base of this state and this region. From an ecological and environmental point of view, it is a clear disaster. An ecosystem contributing 30 percent of the commercial fish harvested in these United States will be destroyed.

As these wetlands are destroyed, the present insurable value of adjoining manufacturing, commercial, utility and other infrastructure will be placed at risk. Ultimately much of that infrastructure may become totally uninsurable.

This state, in cooperation with our federal partners, has to step back and develop a holistic engineering program to reestablish a sustainable coastline. Leading scientists and engineers believe that it can be done. The cost is 14 billion dollars. That is a lot of money. The cost of doing nothing shall be well in excess of 100 billion.

140 ports, the construction of an 11,000-mile network of inland navigation channels, 8,500 miles of levees and floodwalls, and more than 500 dams (Stein et al., 2000). The Corps also manages shoreline protection and restoration, construction of seawalls and jetties, and beach rebuilding. As a result, it has a profound effect on the environmental health of the nation's waterways, floodplains, wetlands, and coastlines.

The Corps has long been criticized for

Newly hatched loggerhead turtles head for the sea. Sea turtle nesting beaches are threatened by development, pollution, and rising sea level.

building expensive and environmentally damaging projects, often with dubious economic justification. Analyses of the Corp's practices by the National Academy of Sciences, the General Accounting Office, the Army Inspector General, and independent experts have shown a pattern of flawed economic and environmental analyses, a process that is strongly biased in favor of project approval, and a failure to follow through with environmental mitigation. The projects resulting from this flawed approval process frequently fail to deliver predicted economic benefits while producing far more environmental damage than anticipated. In addition, the Corps has failed to complete much of the environmental mitigation required for its development projects.

According to Steve Ellis, of Taxpayers for Common Sense, "What Army Corps officials lose sight of when they promote a wasteful project is that the federal taxpayer is the primary client, and is the majority stakeholder of virtually all Corps projects. The Corps needs to be made accountable to the nation as a whole, and its mandate should be a civil works program that will benefit the overall national economy and the welfare of its citizens."

Although perhaps the most influential, the Corps is not the only government agency or program whose actions unnecessarily harm coastal ecosystems. For example, as part of the Central Valley Project, the Bureau of Reclamation helped drain the vast wetlands of California's Central Valley and channelized its rivers. The project resulted in the loss of 95 percent of the wetlands of the Sacramento River Delta. Winter run Chinook salmon have declined by more than 90 percent over the life of the project and an estimated 95 percent of salmon and steelhead spawning habitats are now gone (Koehler and Blair, 2001). This development program has necessitated a 20-billion-dollar restoration program for fish and wildlife in the river delta and San Francisco Bay.

COASTAL DEVELOPMENT AND HABITAT LOSS

Like Louisiana's bayous, all coastal habitat types are affected by development to a greater or lesser degree, depending on their desirability for human uses and their sensitivity to nearby development. Maritime forests, for example, have largely disappeared under the plow

or by residential development. Rapid growth in south Florida has led to the destruction of mangroves and seagrass beds, depriving some fish of feeding and nursery grounds.

Residential and commercial construction destroys wildlife habitat, including habitat not actually built upon. The alteration of water flows; the loss of water quality; the breakup of large areas by roads, canals, and other infrastructure; and the creation of vulnerable exposed "edge" areas all degrade wildlife habitat.

Wetlands are particularly valuable and vulnerable. They support fish and wildlife populations of economic, ecological, and social importance. They also provide ecological services by slowing down and absorbing stormwater, filtering pollutants from urban and agricultural runoff, and buffering coastal areas from storms and erosion.

From the 1780s to the 1980s, the United States (excluding Alaska) lost more than half of its original wetlands (Dahl, 1991). With protection under the Clean Water Act and other statutes, the rate of wetlands loss has dramatically decreased from a peak of about 490,000 acres a year to about 60,000 acres a year today. Most wetland loss today stems from residential and commercial development rather than from agriculture, which previously accounted for the lion's share of loss.

RUNAWAY RUNOFF

Probably the most harmful impact of development on marine and freshwater ecosystems is the degradation that results from polluted runoff. As evidenced by the dead zone in the Gulf of Mexico, transported pollutants can degrade water quality and habitats far from the sources of pollution.

Surfaces that are impervious to water—such as paved roads, parking lots, and rooftops—greatly exacerbate the problem of runoff. A one-acre parking lot, for example, produces about 16 times the volume of runoff that comes from a one-acre meadow (Beach, 2002). Impervious surfaces affect watersheds in two major ways. First, they alter the pattern and rate of flow of rainwater to water bodies. Second, they collect pollutants—hydrocarbons and other harmful substances emitted by automobiles, as well as fertilizers and pesticides from lawns and golf courses—and provide a conduit for their rapid transfer to water bodies.

In general, the abundance and diversity of aquatic species decline as the amount of impervious surface in a watershed increases beyond about 10 percent (Schueler and Holland, 2000). Since suburban development averages about 40 percent impervious cover, environmental quality quickly begins to suffer in rural watersheds once suburban development begins. For example, in Maryland, the abundance of brown trout declines at about 10 to 15 percent of imperviousness as does the abundance of coho salmon around Seattle. Similarly, studies have shown that the diversity of aquatic insects plummets in urban streams.

THE LOGIC OF WATERSHED PLANNING

Watersheds—areas of land that drain to a common waterway—provide a logical and appropriate scale for protecting and restoring water quality. Identifying the major threats to

water quality, inventorying their sources, and determining the pollution reductions needed to protect, maintain, and restore water quality are best done on a watershed-by-watershed basis. Forty-six percent of the U.S. population inhabits coastal watersheds (NOAA, n.d.), but, in a sense, we all live in a coastal watershed since all rivers drain eventually to the sea.

At the local and regional levels, the sources, magnitude, and effects of nutrient and toxic pollution from both point and nonpoint sources vary dramatically. As a result, a one-size-fits-all approach to making our waters fishable and swimmable will not work. But approached on a watershed basis, we can address problems such as nonpoint source pollution, particularly nutrient pollution—the greatest threat to water quality in our rivers, bays, and coastal waters.

We need an approach that manages sources and effects across jurisdictional boundaries, provides the resources and incentives needed to achieve results, and is flexible enough to allow solutions tailored to meet local circumstances.

The essential programmatic elements of a watershed-based approach to water quality protection are already in place. The Clean Water Act requires the establishment of water quality standards for pollutants as well as the calculation of the maximum amount of a given pollutant that a water body can absorb and still satisfy water quality standards (the total maximum daily load, or TMDL). The act also requires an ongoing planning process for complying with water quality standards and maintaining designated uses of water bodies—such as fishing and swimming.

At its core, the problems of coastal development are about human beings and the demands we place on natural resources and ecosystems. We are currently making more demands on coastal and marine ecosystems than they can reliably meet. To preserve and restore the bountiful coastal environment that we have enjoyed in the past and that we want for our children and grandchildren, we must alter our relationship to the environment. Given the certainty of substantial future population growth in coastal areas, only by changing the way we live and the way our communities grow can we maintain, much less restore, healthy coastal ecosystems.

SUMMARY OF RECOMMENDATIONS

1. Develop an action plan to address nonpoint source pollution and protect water quality on a watershed basis.

Addressing the complex array of point and nonpoint sources of pollution related to development requires a comprehensive, watershed-based approach to water quality protection. States should establish and enforce water quality standards for nutrients, thus providing an enforceable benchmark against which progress can be measured. The Clean Water Act and state water quality laws should be amended to require action to reduce nonpoint source pollution. States should determine the total maximum daily load (TMDL) of pollutants that a water body can accept and still attain water quality standards. The states should then implement meaningful plans for achieving the point and nonpoint source pol-

lution reductions indicated by TMDLs. Implementation also requires watershed-based water quality compliance planning, which the federal government can encourage by providing a complementary suite of incentives for improving water quality and disincentives for activities that harm water quality.

2. Identify and protect from development habitat critical for the functioning of coastal ecosystems.
Congress should provide a significant, permanent, and dedicated source of funding for habitat protection. Comprehensive habitat-protection planning by the states is important to ensure that federal, state, and local funds provide the maximum benefit in protecting habitat and water quality. The broadest possible array of financial tools and incentives should be made available to government and private land-protection efforts. Lastly, strong partnerships among all levels of government, private land trusts and foundations, and the business community are crucial for large-scale habitat protection.

3. Institute effective mechanisms at all levels of government to manage development and minimize its impact on coastal ecosystems and their watersheds.
Substantial changes in development patterns and practices on private lands are needed. Municipalities and counties should change their zoning and subdivision codes to promote compact growth in areas where it is desirable, to discourage growth in relatively undeveloped areas where it is not desirable, and to reduce impervious surface cover wherever possible. States should take an active role in developing a consensus on growth management, encouraging urban growth boundaries to protect agriculture and environmentally sensitive lands, and restricting state development funding to designated growth areas. Congress should make federal funding for transportation and development available only to states that comply with the Clean Water Act and other federal environmental laws. Federal grants and loans should be required to be used consistent with state and local growth-management efforts.

4. Redirect government programs and subsidies away from harmful coastal development and toward beneficial activities, including restoration.
The Army Corps of Engineers should be reformed to ensure that its projects comport with the agency's missions, are environmentally and economically sound, and reflect national priorities. Congress should transform the Corps into a strong and reliable force for environmental restoration, working in partnership with natural resource management agencies. Tax structures should be examined at all levels of government to ensure that they are supporting compact, appropriately sited growth. The National Flood Insurance Program should be reformed by setting premiums that reflect the true risk of coastal hazards, phasing out coverage of repetitive loss properties, and denying coverage for new development in hazardous or environmentally sensitive areas.

Chapter Five
CLEANING COASTAL WATERS

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THE NATURE OF THE PROBLEM

The images of the *Exxon Valdez* oil spill in Prince William Sound, Alaska, in 1989, and the sight of trash washing up with the seaweed on our favorite beaches are all too familiar.

What we are less aware of, however, is the amount of pollution that travels daily from each of our lawns, vehicle tailpipes, driveways, and the fields where our food is produced into our coastal waters. A recent study by the National Research Council found that the same amount of oil released in the *Exxon Valdez* spill—10.9 million gallons—washes off our coastal lands and into the surrounding waters every eight months (NRC, 2002). The Mississippi River, which drains nearly 40 percent of the continental United States, carries an estimated 1.5 million metric tons of nitrogen into the Gulf of Mexico each year (Goolsby et al. 1997). Overall, the amount of nitrogen released into coastal waters along the Atlantic seaboard and the Gulf of Mexico from anthropogenic, or human-induced sources, has increased about fivefold since the preindustrial era (Howarth et al., 2000).

The consequences of this polluted runoff are most acute along the coasts, where more than 13,000 beaches were closed or under pollution advisories in 2001 (NRDC, 2002). Two-thirds of our estuaries and bays are either moderately or severely degraded from eutrophication (Bricker et al., 1999). However, pollution's reach extends far beyond our major cities. Scientists report that killer whales have higher PCB levels in their blubber than any animal on the planet and that fish species that live their entire lives far out in the Pacific are too contaminated with mercury to be safe to eat.

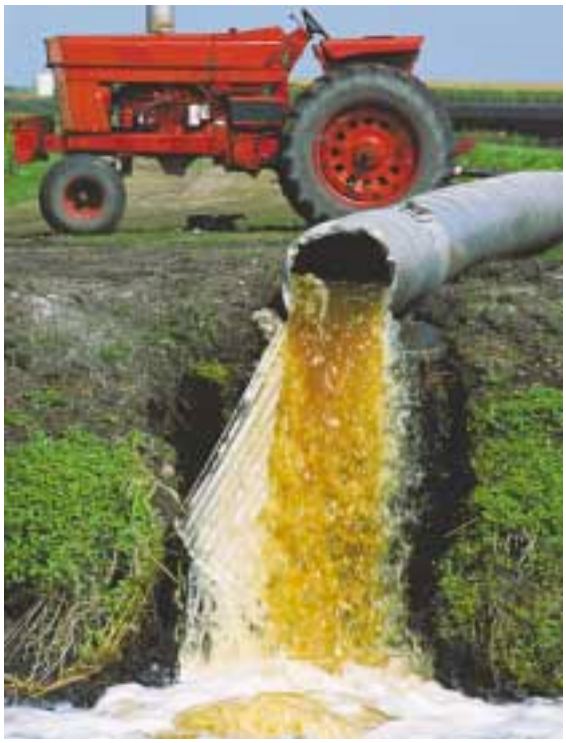
I want my children to grow up unafraid to eat salmon and halibut and other wild foods that are part of our tribal heritage. But the traditional foods that we gather from the ocean have contaminants. My Aunt Violet points out that we aren't just eating one contaminant. We eat the whole fish.

Shawna Larson
Alaska Community Action on Toxics
Pew Oceans Commission hearing, Anchorage, Alaska, August 15, 2001

These are the signs of a silent crisis in our oceans.

Fortunately, we have set a good precedent for addressing water pollution. In response to public outcry over such environmental calamities as the burning of the Cuyahoga River in Ohio, Congress passed the Clean Water Act (CWA) in 1972. The law requires the U.S. Environmental Protection Agency (EPA) to establish national technology standards and science-based criteria for water quality protection. The states then control identifiable sources of pollution by issuing pollution discharge permits based on these technology and water quality requirements.

Efforts resulting from the provisions of the Clean Water Act have succeeded in removing the worst pollution from the rivers and lakes that surround us. Some coastal waters, such as those off Los Angeles and San Diego, have dramatically improved. There, inputs of many pollutants have been reduced by 90 percent or more over a 25-year period, leading to the recovery of kelp beds, fish communities, and certain seabird populations (Boesch et al., 2001).



Cameron Davidson/Workbookstock.com

Runoff from a sugar field in central Florida carries nutrient and other chemical pollution into an adjacent ditch. Nutrients, particularly nitrogen, flowing from farm fields, streets, and yards across the nation represent the largest pollution threat to coastal waters.

But in the 30 years since the Clean Water Act was passed, as scientific knowledge and experience has improved, the focus of our concern has shifted. Although controlling point sources remains critical, the subtler problem of nonpoint sources has moved to the fore. In our oceans, now, we are experiencing a crisis as great as a burning river. It is a crisis we must address through changes in both policy and commitment.

Today, nonpoint sources present the greatest pollution threat to our oceans and coasts. Every acre of farmland and stretch of road in a watershed is a nonpoint source. Every treated lawn in America contributes toxics and nutrients to our coasts. Nonpoint pollutants include excess fertilizers and pesticides used in farming, oil and grease from paved surfaces, bacteria and nutrients from livestock manure, and acidic or toxic drainage from abandoned mines.

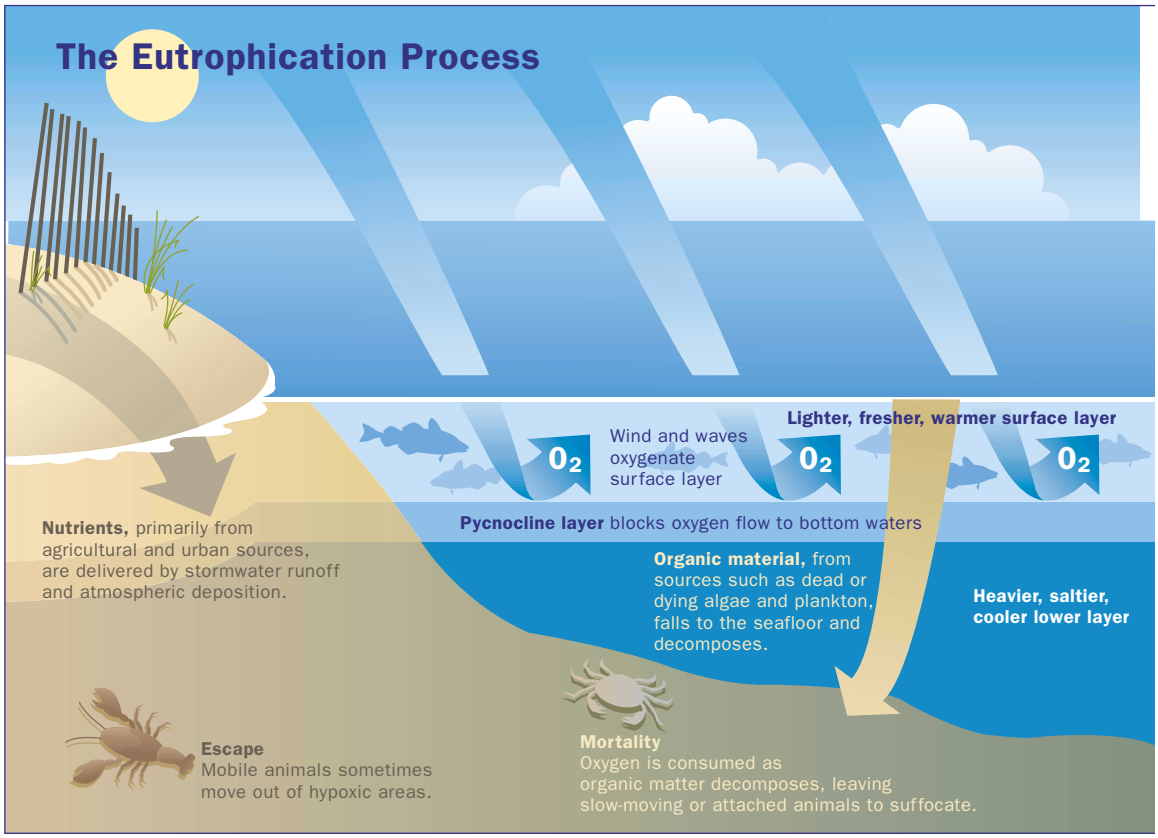
The current legal framework is ill equipped to address this threat. Rather than confronting individual cases, the situation requires that we apply new thinking about the connection between the land and the sea, and the role watersheds play in providing habitat and reducing pollution.

One of the major nonpoint pollutants is nitrogen, a nutrient that encourages plant growth. Although nitrogen is essential to life, in excess it can significantly damage and alter ecosystems. In fact, scientists now believe that nutrients are the primary pollution threat to living marine resources (NRC, 2000). Most nitrogen in the oceans arrives from nonpoint sources, including storm runoff from roads and agricultural fields, and airborne nitrogen emitted from power plants and car tailpipes.

We have also learned that marine species accumulate toxic substances. From single-celled marine life to top ocean predators, including humans, toxic substance levels in body tissue increase as predators consume contaminated prey. In addition, new forms of pollution are emerging. Non-native species, introduced by accident or design, have proliferated to stress entire ecosystems, crowding out native species, altering habitat, and in some instances, introducing disease. And human-generated sound in the oceans is affecting marine life in ways we are just beginning to understand.

Finally, we have not fully dispensed with the problem of point source pollution. Legal loopholes and poor enforcement allow significant point sources of pollution to go unregulated. These include cruise ships, ballast-water discharge from ships, and concentrated animal

FIG. ONE



Eutrophication is a long-term increase in the supply of organic matter to an ecosystem—often because of excess nutrients. Eutrophication creates two harmful effects in marine ecosystems: reduced water clarity and oxygen depletion. Reduced water clarity can starve seagrasses and the algae that live in corals for light, reducing their growth or killing them. While wind and waves aerate surface waters, the pycnocline—a layer of rapid change in water temperature and density—acts as a barrier to oxygen exchange in bottom waters. Oxygen is consumed in this deep layer as bacteria decompose plankton, dead fish, and other organic matter falling from the surface. When dissolved oxygen levels reach two milligrams per liter or less—a condition called hypoxia—most slow-moving or attached animals suffocate, creating areas known as dead zones in the bottom waters.

Source: Boesch et al., 2001; EPA, 2000.

feeding operations. Animal feeding operations alone produce more than three times the amount of waste that people do—about 500 million tons of manure every year (EPA, 2002a).

Through witness testimony from around the country, commissioned papers, and its own research, the Commission investigated five types of pollution—nutrients, toxic substances, cruise ship discharges, invasive species, and anthropogenic sound. It reviewed the current state of our laws and changes necessary to control new and overlooked sources of pollution.

WHEN NUTRIENTS POLLUTE

The immediate cause of the 1991 event that killed one million menhaden in North Carolina's Neuse River was a single-celled creature called *Pfiestera piscicida*. Known as the killer alga, *P. piscicida* can emit a strong neurotoxin when in the presence of schools of fish. It feasts on the dead and dying fish, reproduces, and then settles back into the sediment. Scientists have found that *P. piscicida* thrives in coastal waters that are enriched with nutrients such as phosphorous and nitrogen.

The Neuse River outbreak was linked by analyses of the event to nutrients flowing from manure lagoons and other agricultural sources in the watershed.

We are degrading the environment along our coasts. Nutrient pollution has been linked to harmful algal blooms, such as the *Pfiestera* outbreak. It has also been linked to dead zones, such as the area in the Gulf of Mexico that appears annually and has reached the size of Massachusetts (more than 8,000 square miles). In addition, this pollution results in the loss of seagrass and kelp beds, destruction of coral reefs, and lowered biodiversity in estuaries and coastal habitats (Howarth et al., 2000). The incidence of harmful algal blooms along the United States coastlines increased from 200 in the decade of the 1970s to 700 in the 1990s, and now includes almost every coastal state in the U.S. (Burke et al., 2000) One bloom off the coast of Florida was implicated in the deaths of more than 150 manatees (NOAA, 2002).

The continued loss of wetlands is further evidence of this trend in degradation. Wetlands serve a critical function as natural filters that remove nutrients before they can reach the sea, but they are being lost at the rate of approximately 60,000 acres per year (Dahl, 2000). If current practices of nutrient input and habitat destruction continue, nitrogen inputs to U.S. coastal waters in 2030 may be 30 percent higher than at present (Howarth et al., 2002).

When too many nutrients—particularly nitrogen—enter the marine environment, the result is eutrophication—the overenrichment of the water that stimulates extraordinary growth of phytoplankton and attached algae (Figure One, page 61). Phytoplankton blooms can be so dense they block the light needed by corals and by submerged vegetation such as seagrasses. Severe light deprivation will kill the plants and cause corals to expel the algae they host, which leads to coral bleaching.

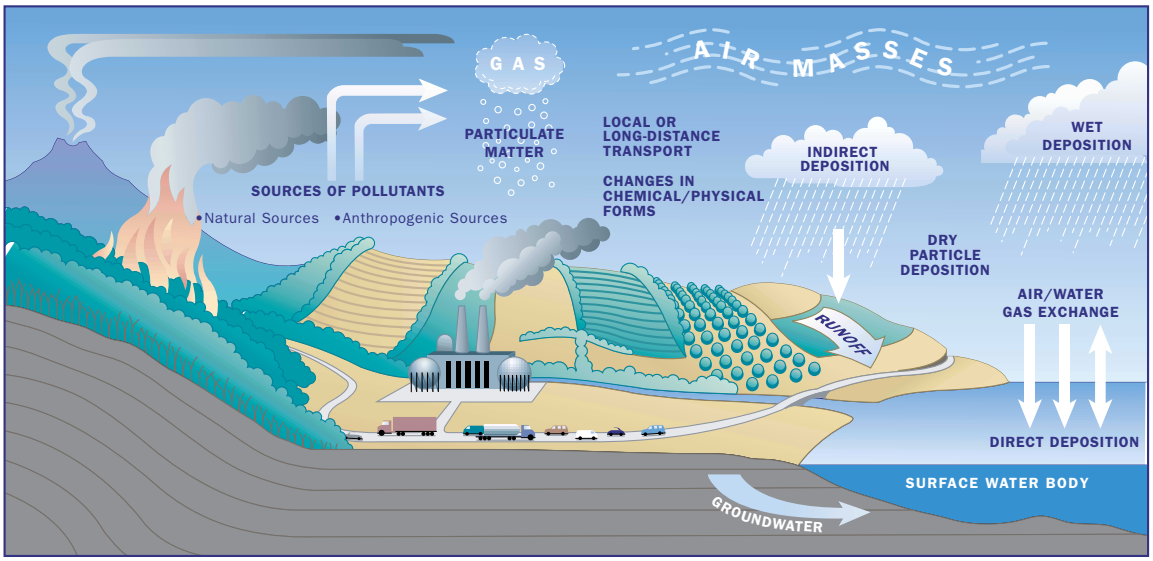
After the phytoplankton die and sink to the ocean floor, bacteria decompose them. Decomposition pulls oxygen from the water, leaving the remaining plants and animals oxygen-starved. Areas with little oxygen, called hypoxic, are unable to support fish and shrimp populations, and the stress of hypoxia can make them more vulnerable to invasive species, disease, and mortality events. In addition to the well-known hypoxic dead zone at the mouth of the Mississippi River, hypoxic zones have developed in 39 estuaries around the U.S. coast (Bricker et al., 1999).

Of the myriad sources of nutrient pollution, agriculture is the most significant. Nitrogen in fertilizer is easily dissolved in and transported by water. Animal wastes are also nitrogen rich, and are generally applied to farmland, where the nitrogen can be washed into water bodies by rainstorms. Aggravating this problem, tile drainage systems constructed to collect and shuttle excess water from fields—particularly common in the corn and soybean fields of the Midwest—provide an expressway for nitrogen flowing into waterways.

Until recently, atmospheric deposition—the settling of airborne pollutants on the land and water—has been an overlooked source of nitrogen pollution in coastal waters. It is now clear that it is widespread and quantitatively important in some regions. Most atmospheric deposition of nitrogen originates as nitrogen oxide emissions from power plants and automo-

FIG. TWO

Atmospheric Release, Transport, and Deposition Processes



Art: John Michael Vanson

Atmospheric deposition is the process by which air pollution directly or indirectly finds its way into our lakes, rivers, and—ultimately—the oceans. Natural and anthropogenic sources of air pollution produce gases (such as oxides of nitrogen and sulfur) and particles (such as soot, which may contain hydrocarbons, various forms of sulfur and nitrogen, and other pollutants). Particles can settle on their own on land or in water (dry deposition), or when washed from the atmosphere by precipitation (wet deposition). Particles settling on land can be resuspended in storm runoff and find their way into water bodies. Gases in the atmosphere are absorbed to varying degrees by water. They are sometimes absorbed directly across the surface of a water body. Gases are also absorbed by water in the atmosphere, and eventually precipitation brings them to water bodies.

Source: Boesch et al., 2001; 2003; EPA, 2000.

biles, and ammonia gas released from animal wastes (Boesch et al., 2001; Figure Two).

In addition to nonpoint sources, there are major point sources of nutrients, particularly concentrated animal feeding operations (CAFOs). Most animal wastes from CAFOs are stored in open lagoons, which can be larger than five and a half football fields and contain 20 to 45 million gallons of wastewater (NRDC and CWN, 2001). If not properly managed, lagoons can leach nutrients and other substances into waterways and overflow during rainstorms. The liquid effluent, rich in nitrogen and phosphorous, is sprayed onto agricultural fields as fertilizer, often at many times the amount needed for crop growth. On a day-to-day basis, the over-application of animal waste to land, which fouls waterways with runoff, is a significant environmental problem.

Although they are regulated under the CWA, CAFOs have largely avoided pollution restrictions because of exemptions in outdated regulations and the states' failure to enforce permitting requirements. Of the approximately 15,500 operations that meet EPA's definition triggering regulation, less than 30 percent have permits, reducing the government's and the public's ability to monitor and control CAFO-related pollution. EPA recently revised its CAFO regulations, which now expressly require all CAFOs over a certain size to obtain a point source discharge permit. EPA's new regulations require CAFOs to develop a nutrient management plan by 2006, but EPA has not set

enforceable standards for these plans, which will be written by the operators and not subject to government or public review. In exchange for developing and implementing a nutrient management plan, CAFOs are shielded from liability for pollution that is discharged off the facility's land application area.

Regardless of its source, nitrogen has become one of the most pervasive and harmful pollutants in coastal waters. A revitalized pollution policy must reflect this understanding.

TOXIC WATERS

When the *Exxon Valdez* ran aground in Alaska and spilled its oil cargo in March 1989, scientists, managers, and hundreds of volunteers rushed to rescue thousands of seabirds and sea otters. They picked the birds off soiled beaches and attempted to clean their plumage before the birds lost their ability to float and to stay warm. In the end, some 30,000 seabirds perished as well as 1,000 or more sea otters, and untold numbers of fish. Congress has since passed the Oil Pollution Act to reduce the risk of similar tanker accidents.

New evidence strongly suggests that components of crude oil, called polycyclic aromatic hydrocarbons (PAHs), persist in the marine environment for years and are toxic to marine life at concentrations in the low parts-per-billion range (Carls et al., 1999). Chronic exposure to PAHs can affect development, increase susceptibility to disease, and jeopardize normal reproductive cycles in many marine species.

PAHs represent just one class of toxic substances that threaten the health of marine species and of humans who depend upon them for food. The Commission focused on three toxic substances of particular concern: PAHs, PCBs (polycholorinated biphenyls), and heavy metals like mercury. These substances are both pervasive and persistent. They are decomposed very slowly, if at all, by bacteria, and do not leave the marine environment quickly or completely. Although now banned in domestic manufacture of electrical transformers, plastics, paints, and other materials, PCBs are still present in many imported materials and at many industrial and military sites. Mercury levels are on the rise in some regions. Nearly 80 percent of the mercury in the marine environment arrives as air emissions from coal-fired power plants and other combustion sources, some of them overseas (Heintz et al., 1999).

Landfills, urban runoff, ocean dumpsites, ocean vessels, and the burning of fossil fuels are just a few of the pathways that bring toxic substances to the oceans.

Toxic compounds enter marine food chains either directly from the water or from concentrated deposits in sediments. Organisms accumulate toxic substances in their tissues, where they may be passed up the food chain. Some of these compounds are concentrated at each step in the chain. The ocean's top predatory fish and marine mammals therefore often have the highest concentrations of toxic compounds in their bodies. Killer whales, walruses, and tuna are among those most contaminated.

Accumulated toxic substances disrupt hormone cycles, cause birth defects, suppress the immune system, and cause disorders resulting in cancer, tumors, and genetic abnor-

malities. In some instances, accumulated toxic substances can even cause death in marine animals (MMC, 1999).

The contamination of certain commercial species may pose particular problems for humans. Recent studies sponsored by *The Mobile Register* indicated that the presence of methylmercury (the bio-available form of mercury, and the form most prevalent in fish) in several species of fish in the Gulf of Mexico, including ling, amberjack, and redfish, may be so great that Food and Drug Administration standards would prohibit selling them to the public. In 2001, of the 2,618 fish advisories issued in U.S. waters, almost 75 percent were for mercury contamination (EPA, 2002b). In Alaska and other polar regions, the evidence of correlation between increased toxic loads and declining health in humans and animals alike is mounting (AMAP, 2002).

The Arctic and Antarctic are hard hit by certain persistent toxics, especially heavy metals and organochlorines, which include PCBs, due to the peculiar mechanisms by which these compounds are preferentially transported to the polar regions. Airborne toxics are repeatedly deposited and volatilized as they are swept by atmospheric circulation from their points of origin toward the polar regions. This process is known as the grasshopper effect because the substances "hop" from their sources to their ultimate repositories in the polar marine environment.

Not enough is being done to address the dangers that toxic substances pose to marine species and to humans. There are no water quality standards for PAHs under the CWA, no ambient air quality standards for mercury under the Clean Air Act (CAA), no systematic monitoring of toxics levels in most species consumed by humans, and there is insufficient effort to clean up toxic contaminants in sensitive marine environments. These policy shortcomings should be addressed without delay.

CRUISE SHIPS

Cruise ships can offer spectacular views and unparalleled wildlife experiences. For many Americans, cruises provide their only exposure to the oceans and marine wildlife, and the popularity of this activity is increasing. In

Joel W. Rogers

Cruise ships with as many as 5,000 passengers visit some of our most spectacular coastal destinations. Sewage and other waste discharges from these floating cities can have significant impacts on marine life and the environment.

recent years the cruise ship industry has grown at an average annual rate of eight percent, and expansion continues. In 2001, the North American cruise industry set a record when it carried 8.4 million passengers. In San Francisco Bay, a new cruise terminal is expected to more than double the number of ship visits per year. Cruise ships make frequent stops in Florida, the Caribbean, along the West Coast, Maine, and Alaska.

While taking a cruise can provide an invaluable experience for passengers, cruise ships can pose a particular risk to the very environments they seek to explore. With as many as 5,000 people onboard, a cruise ship is akin to a floating city, where people go about many of the same activities as they do at home: showering, cleaning, cooking. In addition, cruise ships offer such amenities as photo developing, hairdressing, and dry cleaning. The waste from these activities, however, is not regulated like waste produced from cities.

In one week, a typical cruise ship generates 210,000 gallons of black water (sewage), 1,000,000 gallons of gray water (shower, sink, dishwashing water), 37,000 gallons of oily bilge water, more than eight tons of solid waste, millions of gallons of ballast water containing potential invasive species, and toxic wastes from dry cleaning and photo processing laboratories* (Royal Caribbean Cruises Ltd., 1998; Eley, 2000; Holland America, 2002). This effluent, when discharged untreated—as too often happens—delivers human pathogens, nutrients, and hazardous substances directly to the marine environment. The wastewater pollution from these ships is compounded by air pollution from burning trash and fuel emissions that enter the marine environment via atmospheric deposition.

Despite the fact that cruise ships discharge waste from a single source, they are exempted from regulation under the CWA point source permitting system.

The CWA allows the discharge of untreated black water anywhere beyond three miles from shore, and does not require any treatment of gray or ballast water. Only in Alaskan waters are cruise ships required to meet federal effluent standards; treat gray water discharges; and monitor, record, and report discharges to state and federal authorities. In addition, the CWA authorizes the U.S. Coast Guard to inspect the discharge logs and pollution control equipment aboard ships. However, Coast Guard officers are not required to test discharges for compliance.

The CWA and the Act to Prevent Pollution from Ships together regulate bilge water, which must be run through an oil-water separator before it is discharged. The National Invasive Species Act encourages all oceangoing vessels to exchange ballast water but does not require them to do so. The air emissions from ships are covered under the CAA amendments of 1990, but the EPA has yet to impose regulations.

In short, the legal regime that covers cruise ships is complex but not comprehen-

*Based on a 3,000-passenger cruise ship and EPA estimates of per capita waste generation.

sive. Unless we take greater steps to control discharges and reduce pollution, we will continue to harm the very places we love to visit.

INVASIVE SPECIES

Invasive species—non-native species whose introduction harms or is likely to harm the environment, economy, or human health—present one of the most significant threats to biodiversity and healthy ecosystems (GISP, 2002). Once introduced, they have the potential to establish themselves alongside, or in place of, existing species. They can compete with native species for prey and habitat, facilitate the spread of diseases, introduce new genetic material, and even alter landscapes. Invasive species can impede endangered species conservation and restoration efforts. In the marine environment, some compete with commercially significant fish species for food and habitat, or they clog nets and eat bait. On land and in the sea, invasive species are responsible for about 137 billion dollars in lost revenue and management costs in the U.S. each year (Pimentel et al., 1999).

Invasive species are hard to identify and eradicate before they take hold in an ecosystem, which can occur remarkably quickly. For example, every 14 weeks, a new invasive species is discovered in the San Francisco Bay (Cohen and Carlton, 1998).

Ballast water is the primary vector for the release of invasive species into marine waters (Carlton, 2001). Ballast water—and all the living creatures contained within it—is pumped into and out of oceangoing vessels for stabilization. Often it is taken up in one port and discharged in another. Every day, some 7,000 species are transported around the world via ballast water (Carlton, 2001).

Ron Silva

Invasive species, such as these Chinese mitten crabs, represent one of the greatest threats to biodiversity. Invasive species compete with native species for prey and habitat, and are responsible for about 137 billion dollars in lost revenue and management costs in the U.S. each year.

Another important vector is aquaculture. Species such as Atlantic salmon, grown on the western coasts of the U.S. and Canada, act as invasive species if they escape or are released unintentionally from aquaculture facilities into the surrounding waters. Once in the wild, they can compete with native species for food, shelter, and other resources, as well as spread disease. In some cases, species raised for aquaculture may interbreed with native species, potentially threatening the viability of native stocks.

Other vectors include the home aquarium industry, ship hulls, oil platforms, and marine debris. Invasive species arrive in seaweed used to pack live bait and via the pet trade industry. They also reach U.S. waters as live food imports. The Internet has significantly aided the introduction of new species. Today, consumers need only a credit card, access to a computer, and a delivery address to purchase marine life for food, for use as bait, or as pets.

In an increasingly global economy, all this mobility represents a serious threat to the health of living marine resources.

Our laws are not equipped to deal with these threats. Biological pollution by invasive species is the focus of the National Invasive Species Act of 1996 (NISA). However, under the NISA structure, invasive species are managed on a case-by-case, crisis-by-crisis basis, and the national focus is on terrestrial invasive species.

BOX ONE

Steve Simonsen/Marine Scenes

INVADING SEAWEED

A green alga known as *Caulerpa taxifolia*—native to tropical waters of the world—became popular as a decorative plant in saltwater aquariums after a fast-growing, cold-tolerant strain of the species was cultured. If released into the wild, this seaweed can proliferate, carpeting the ocean floor and crowding out native species that provide food and shelter within the ecosystem. It is unpalatable to most fish because of a toxin it contains. A piece as small as one centimeter can grow into an infestation.

In the early 1980s, *C. taxifolia* was introduced into the Mediterranean Sea. By 2001, it had spread across more than 30,000 acres of the seafloor, displacing native communities in its path. Scientists believe the alga is so widespread in the Mediterranean Sea that eradication is no longer a possibility.

In June 2000, two divers in California discovered *C. taxifolia* in native seagrass beds in a coastal lagoon in Carlsbad. They reported their discovery to an algal expert, who alerted government authorities. Scientists suspect the seaweed was inadvertently released into a lagoon from a home aquarium.

A rapid response team was formed, and an effort to eradicate the invading seaweed was mobilized within a few days. Biologists surveyed the infested areas, identifying patches of the seaweed. They covered the patches with heavy plastic tarps to contain the seaweed and injected chlorine under the tarps—a treatment that killed not only *C. taxifolia* but also everything else under the tarps.

Eradication efforts appear to have been effective. A survey in the fall of 2002 found no trace of the seaweed, but scientists caution that it could reappear when summer brings increased sunlight and warmer waters.

Intensive media coverage of the Carlsbad invasion led to the discovery of a second infestation in Huntington Harbour, near Los Angeles. Biologists are treating this invasion in a similar manner with equally encouraging results. Scientists hope that the rapid response to this threat will prevent an invasion like the one in the Mediterranean Sea. Two invasions of the alien seaweed have also occurred in Australia.

The experience with *C. taxifolia* in the U.S. demonstrates the merits of prevention to avoid the uncertainties and costs of eradication. So far, nearly 2 million dollars have been spent to fight the California invasion. In January 2003, California approved an additional 1.3-million-dollar grant for further eradication efforts.

To the extent that NISA addresses marine species, it does so almost exclusively in the context of ballast-water discharges, despite the existence of many other vectors. Ballast-water exchange (BWE) is a procedure in which ships in the open ocean dump ballast water taken aboard in foreign ports. Its purpose is to lessen the chance of introducing coastal invasive species into potentially hospitable habitats in destination ports. However, BWE does not always dislodge species and it does not apply to coastwise travel, which can also allow species to be transported to new environments. Additionally, BWE is not mandatory under NISA. Although the U.S. Coast Guard is required to check ship logs to determine whether an exchange occurred, it is not required to check the ballast tanks. Current guidelines encourage ship operators to report voluntary exchange, but compliance with this minimal requirement is weak.

There is little law focusing on other vectors of invasive species. For example, there is no uniform regime in place to track live imports either entering or traveling around the country. There is no systematic process for determining which management approach is best when a species is found, no central source of information for researching species, and no dedicated source of funding to control invasive species. For species like the destructive seaweed, *Caulerpa taxifolia*, which grows as much as three inches a day, any delay in response could have severe environmental and economic ramifications (Box One).

Currently, agencies at different levels of government report commodities using a different nomenclature and verification system. With such inconsistency, neighboring states could simultaneously be working to promote and eradicate the same species, and one agency's food list could be another agency's most wanted list of invaders. The lack of regulatory clarity was brought home by the discovery of the invasive snakehead fish in a Maryland pond. Federal regulations did not prohibit the importation or interstate transportation of this Asian fish and state law provided only a mild penalty for release of the fish, for which the statute of limitations had expired. Furthermore, state managers had no clear legal authority to eradicate the population that had established itself. This type of confusion results in invasive species—literally—slipping through the regulatory cracks and getting into the environment without anyone noticing.

SOUND

The use of anthropogenic sound as a tool in the ocean has become enormously valuable for scientists, engineers, fishermen, and the military. It allows fishermen to locate schools of fish and to keep predators from raiding or becoming entangled in their nets. The use of sound also helps mariners detect icebergs and other obstructions, biologists study behavior changes in marine species, oceanographers map the bottom of the ocean floor, geologists find oil and gas, climatologists research global climate change, and the U.S. Navy detect submarines.

Many marine species, including marine mammals, turtles, and fish, also rely on sound. They use vocalizations and their ability to hear to detect predators, prey, and each other. In the oceans, as on land, sound is essential

for communication.

Anthropogenic sound in the ocean is on the rise, mainly due to increased vessel traffic. Coastal development is bringing more pleasure craft, and globalization and international trade require more commercial vessels. In addition, the navies of the United States and other nations are increasingly using active sonar systems to patrol coastal waters for enemy submarines. Meanwhile, oil and gas operations on the outer continental shelf are expected to spread into deeper waters. Climate change, too, may have a significant effect on sound levels in the ocean. Not only does sound travel faster in warmer water, but also rising temperatures and melting ice at the poles may open new shipping channels in areas that have previously experienced little vessel traffic.

Sound sources differ in both their intensity and frequency, and thus can have varied effects on species. Sounds in the same frequency ranges used by marine species can mask acoustic communication among animals and interfere with detection of prey and predators. High-intensity sounds can cause pain and, in some circumstances, tissue and organ damage. If the pressure resulting from the sound is intense enough, the animal can experience internal bleeding and subsequent death.

A mass stranding of whales in 2000 heightened concerns about the effects of sound in the oceans. In March of that year, at least 17 whales were stranded on beaches in the northern Bahama Islands. Most of the animals were alive when they stranded and eight of them were returned to the sea. The other nine animals died; pathology reports revealed bruising and internal organ damage. The stranding occurred about the time that ten U.S. Navy vessels were operating their mid-frequency sonar systems nearby. Investigations conducted cooperatively by the Navy and the National Marine Fisheries Service suggested that the sonar transmissions were a critical factor in the strandings (NOAA, 2001).

Low-intensity sounds can disrupt behavior and cause hearing loss, ultimately affecting longevity, growth, and reproduction. Frequent or chronic exposure to both high- and low-intensity sounds may cause stress, which human and terrestrial animal studies indicate can affect growth, reproduction, and ability to resist disease. Impulse sounds, such as those produced by explosions and seismic air guns, may damage or destroy plankton, including fish eggs and larvae, as well as damage or

Tim Aylen/Vision Media

Local children examine a whale stranded in the northern Bahama Islands in 2000. During March, at least 17 whales beached themselves subsequent to Navy sonar operations nearby. Investigations suggested that the sonar transmissions were a critical factor in the strandings.

destroy tissues and organs in higher vertebrates (Hastings et al., 1996; Gisiner, 1999).

The Marine Mammal Protection Act (MMPA), Endangered Species Act (ESA), and the National Environmental Policy Act (NEPA) all provide legal mechanisms for addressing sound. However, the MMPA and ESA apply only to marine mammals and endangered species, and are only capable of protecting individuals from particular sound-related projects, such as drilling operations or sonar activities. In addition, the federal government has recently proposed to exempt certain activities from environmental review under NEPA. Because review under these statutes is triggered only on a case-by-case basis and does not effectively address cumulative impacts on marine ecosystems, underwater sound as a source of potentially significant pollution in the marine environment has not received comprehensive treatment. A new policy framework is needed to adequately address this emerging pollution concern.

ACTION TO REDUCE MARINE POLLUTION

For too long our oceans have been dumping grounds. Within U.S. waters, ecosystems are subjected to insults from nonpoint, unregulated point, and nontraditional types of pollution from both land- and ocean-based sources. Nutrients, toxics, cruise ship discharges, acoustic and biological pollution, and invasive species all harm marine ecosystems, and the legal regimes in place do not match the nature of today's pollution threats. For each of these pollution sources, policy changes can and should be made as quickly as possible.

SUMMARY OF RECOMMENDATIONS

1. Revise, strengthen, and redirect pollution laws to focus on nonpoint source pollution on a watershed basis.

EPA and the states should establish water quality standards for nutrients, especially nitrogen, as quickly as possible. EPA and the states should also ensure that water quality standards are in place for other pollutants—such as PAHs, PCBs, and heavy metals such as mercury—where these are identified as problematic on a watershed-by-watershed basis. Congress should amend the Clean Water Act to require the use of best management practices to control polluted runoff resulting from agriculture and development. Congress and the executive branch should provide substantial financial and technical support for the adoption of such practices. Congress should link the receipt of agricultural and other federal subsidies to compliance with the Clean Water Act. Finally, Congress and the Environmental Protection Agency should ensure that air emissions of nitrogen compounds, mercury, and other pollutants are reduced to levels that will result in a substantial reduction of their impact on marine ecosystems.

2. Address unabated point sources of pollution.

Concentrated animal feeding operations should be brought into compliance with existing provisions in the CWA. Congress should enact legislation that regulates wastewater discharges from cruise ships under the CWA by establishing uniform minimum standards for discharges in all state waters and prohibiting discharges with-

in the U.S. Exclusive Economic Zone that do not meet effluent standards. Congress should amend NISA to require ballast-water treatment for all vessels that travel in U.S. waters, and regulate ballast-water discharge through a permitting system under the CWA. Finally, the International Maritime Organization draft convention on ballast-water management should be finalized and its provisions implemented through appropriate U.S. laws.

3. Create a flexible framework to address emerging and nontraditional sources of pollution.

A national electronic permitting system should be created under NISA to facilitate communication and track imports of live species that may result in aquatic introductions. Each state should inventory existing species and their historical abundance, in conjunction with the development of the regional ocean governance plans under the National Ocean Policy Act. Congress should provide adequate funding for developing statewide invasive-species management plans that include provisions for inventorying, monitoring, and rapid response. With regard to sound, a comprehensive research and monitoring program should be developed to determine the effects of sound sources on living marine resources and ecosystems. Consideration should be given to requiring the utilization of best-available control technologies, where the generation of sound has potential adverse effects. Finally, the environmental ramifications of any sound-producing project should be taken into formal consideration—pursuant to NEPA or other applicable statutes—at the planning stages of the project, before significant resources, time, and money have been devoted to its development.

4. Strengthen control of toxic pollutants.

The U.S. should ratify the Stockholm Convention on Persistent Organic Pollutants (POPs), and implement federal legislation that allows for additions to the list of the "dirty dozen" chemicals. In concert with this effort, EPA should develop and lead a comprehensive monitoring program to quantify levels of particular toxic substances in designated ocean habitats and species, and sufficient resources should be devoted to studying the effects of toxics on marine species. This monitoring program should be coordinated with Food and Drug Administration and EPA seafood contaminant advisory efforts, so that people know where their seafood comes from and what it contains.

Chapter Six
GUIDING SUSTAINABLE MARINE AQUACULTURE

Farm-raised oysters, Eliot, Maine
Laura Stadig, Spinney Creek Shellfish, Inc.

A new industry is taking shape along our shores. Aquaculture—the farming of fish, shellfish, or aquatic plants—has grown rapidly over the past several decades, and that growth is accelerating. Today, some 4,000 aquaculture enterprises in the United States, most of them small to mid-size, supply Americans with Atlantic salmon, hard clams, oysters, shrimp, and nearly all the catfish and trout we eat. As the industry matures, it holds both great promise and great risk.

It holds great promise because demand for seafood is rising, yet the total global wild fisheries catch has leveled out since the mid-1990s as fish stocks have become depleted. In the U.S., 30 percent of the known wild fishery stocks are already overfished or in the process of being depleted through overfishing. Aquaculture represents another source of seafood to boost the fish supply. Although the majority of aquaculture operations raise freshwater species, our work focused on marine species. Some forms of aquaculture, such as mollusk farming, may aid the environment. Because mollusks, such as clams and oysters, filter large volumes of water, they can help to restore marine ecosystems polluted with nutrients and an overabundance of phytoplankton. The industry is also a source of new jobs. During a site visit in Florida, the Commission learned about a job-retraining program that redirects displaced gillnet fishermen into hard clam aquaculture.

But despite this promise, marine aquaculture poses significant risks (Figure One, page 74). Farmed fish that escape their pens may pose biological risks to wild populations. Improper facility design, siting, and operation can reduce water quality, damage the physical habitat, and harm wild populations in a variety of ways. Different species and production systems present different challenges and risks, complicating management.

...aquaculture is here to stay; the challenge is to ensure the young and growing industry develops in a sustainable manner and does not cause serious ecological damage.

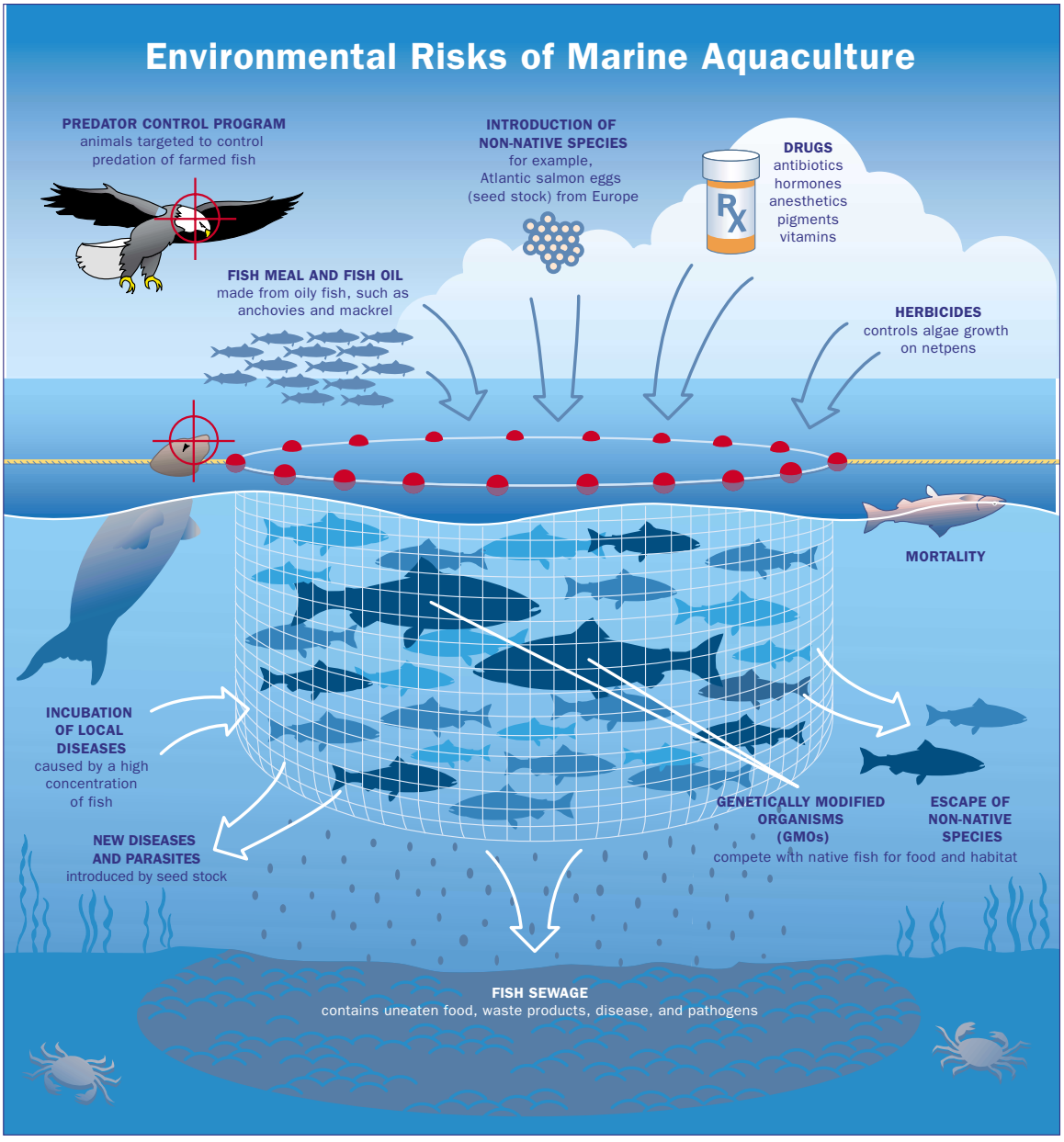
Rebecca J. Goldburg and others, 2001
Marine Aquaculture in the United States: Environmental Impacts and Policy Options

This combination of promise and risk has made marine aquaculture an important focus of the Commission's work. Because the aquaculture industry is still young and relatively small, there is time and opportunity for it to develop in an ecologically sound way. If we are to prevent, minimize, and mitigate the risks, we must develop a coherent policy framework for the industry.

PROFILE OF AN INDUSTRY

Aquaculture began on a small scale, thousands of years ago, as an ancient form of animal husbandry. Today, one-third of the fish products entering global markets are farm raised. The United States ranks eleventh in worldwide aquaculture production (just over one percent), farming roughly one billion pounds of aquatic species, mostly freshwater species such as catfish, valued at nearly one billion dollars in 1998. However, the U.S. ranks third in national consumption of seafood.

FIG. ONE



Art: John Michael Vanson

Like other forms of animal production, aquaculture can lead to environmental degradation. Non-native and genetically modified species that escape from netpens may compete with native species or contaminate the native gene pool. Large concentrations of fish in aquaculture facilities may incubate diseases and parasites and introduce them into surrounding ecosystems. The use of large quantities of wild-caught fish to feed carnivorous farmed species, such as salmon and shrimp, places additional stress on wild fisheries. Uneaten food, fish waste, and dead fish can contaminate waters near aquaculture facilities. Antibiotics, pesticides, hormones, and other chemicals used to improve production may have harmful effects in surrounding ecosystems. Lastly, the physical presence of aquaculture facilities alters natural habitat and attracts predators, such as marine mammals, which can be entangled in netpens or harmed by intentional harassment techniques.

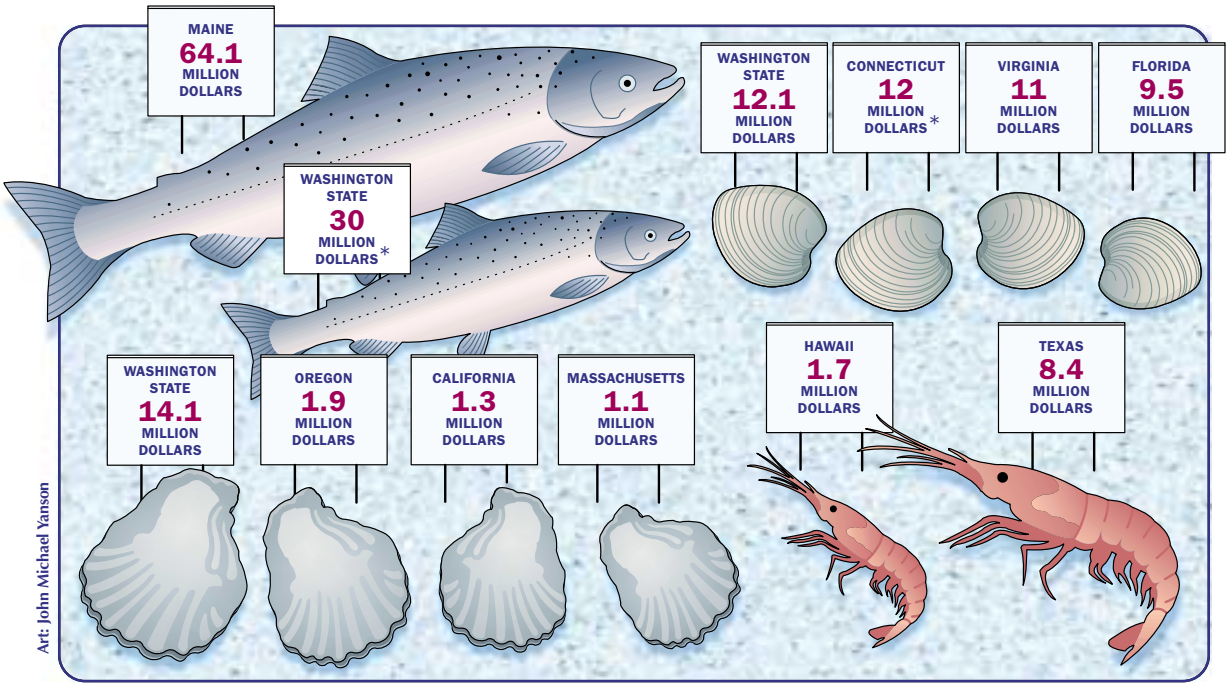
Source: Goldburg et al., 2001; art adapted from the David Suzuki Foundation, 1996.

FIG. TWO

1998 U.S. Aquaculture Production

Value of Prominent Farmed Marine Animal by Key-Producing States

The major marine animals farmed in the United States are salmon, clams, oysters, and shrimp. The 1998 production of these organisms is recorded here as the value of the farmed product in millions of dollars.



*Estimated; exact figures are not available due to confidential data.

Thus, our appetite for seafood relies on high levels of imports—much of which are farmed by nations with less rigorous environmental standards—to meet demand.

In the United States and other developed countries, where farmed salmon and shrimp sell for a high price, aquaculture is a profitable business. The U.S. industry grows nearly 30 marine species, but just four—Atlantic salmon, hard clams, oysters, and shrimp—contribute roughly one-quarter of the total U.S. aquaculture harvest (Figure Two). Salmon and clam production have increased most rapidly within the last several decades. Growth in farming other species has been limited by the lack of available high-quality coastal sites. Aquaculture operations need large areas with access to unpolluted water. The crowded and contested nature of our coasts precludes fish-farming in many areas.

The open seas are a different matter. Private and government interests are encouraging development of an offshore aquaculture industry in the U.S. Exclusive Economic Zone (EEZ), from 3 to 200 miles out to sea. The Department of Commerce's aquaculture policy calls for a fivefold increase in aquaculture production by 2025, and the open oceans

figure prominently in this call.

The aquaculture industry is therefore poised for a major expansion. Before this expansion occurs, it is essential that government and industry address the risks that come with aquaculture.

RISK TO WILD POPULATIONS

Since 1986, nearly one million non-native Atlantic salmon have escaped from fish farms in the Pacific Northwest and have established breeding populations in wild rivers. It is biological pollution—the escape of farmed species and their parasites and pathogens into the environment. This phenomenon represents the most significant threat posed by aquaculture to wild marine populations. Most marine aquaculture operations inadequately separate cultured fish and their diseases from surrounding seas, making such escapes and contamination inevitable.

Once released into an ecosystem, non-native species are extremely difficult to control or eradicate, and often become permanently established, threatening native species and entire ecosystems (Carlton, 2001). Non-native escapees from fish farms can compete with wild stocks for food, habitat, and spawning grounds (Myrick, 2002; Stickney and McVey, 2002). Interbreeding may change the genetic makeup of wild fish and decrease their survivability.

These concerns are especially important where remaining wild populations, such as wild salmon in Maine and the Pacific Northwest, are already endangered. For instance, a storm in December 2000 resulted in the escape of 100,000 salmon from a single farm in Maine. The escapees far outnumber the few wild salmon—only 75 to 110 adults in 2000—that still return to spawn in Maine rivers (NRC, 2002).

Fish farms can also serve as incubators for disease, which can infect wild populations. Infectious salmon anemia (ISA), a virulent and deadly disease, was found in farm-raised Atlantic salmon along the Maritime Provinces of Canada in the mid-1990s. Although many anticipated its spread into U.S. waters, nothing was done to prevent it. As a result, the disease appeared in Maine in 2001. In January 2002, the Maine Department of Marine Resources and the U.S. Department of Agriculture ordered the eradication of 1.5 million salmon located in seven facilities in Cobscook Bay that were infected with, or exposed to, ISA. The cost to the American public was 16.4 million dollars in federal assistance.

Another looming issue in marine aquaculture is the proposed use of genetically modified organisms, which represent another potential source of biological pollution. Although no transgenic fish products are commercially available in the United States, at least one company has applied for permission to market the first engineered animal for human consumption: a farmed Atlantic salmon.

Using genetic material inserted from Coho salmon and ocean pout, the altered salmon grows rapidly, allowing it to hit the market sooner at a reduced cost to growers. Transgenic species may act like invasive species if introduced into the wild. Scientists are concerned about the potential for competition between escaped transgenic fish and wild stocks. In addition, they fear that trans-

genic fish may introduce and spread modified genes throughout wild populations, and ultimately modify the wild gene pool (Hedrick, 2001; NRC, 2002). The ramifications of such irreversible changes are unknown.

Fish farms depend on pelleted fish feed to meet the dietary requirements of carnivorous species such as salmon and shrimp. Feeds typically contain fish meal and fish oil from wild-caught fish, such as anchovies and mackerel. Scientists estimate that producing one pound of farmed shrimp or salmon requires more than twice that amount of wild-caught fish. Large catches of these fish strain ecosystems. This problem will increase if the demand for feed products grows with the expansion of the aquaculture industry. Research to develop feed substitutes for fish meal, such as use of soybean oil, is making progress (Naylor et al., 2000; Goldburg et al., 2001).

Dean Abramson

This nearshore salmon aquaculture facility in Lubec, Maine, is among some 4,000 aquaculture enterprises in the United States. These seafood farms grow hard clams, oysters, shrimp, catfish, trout, and salmon.

RISK TO WATER QUALITY

Water flows freely over cultivated shellfish beds and through the mesh netpens on finfish farms, spreading farm by-products into the surrounding environment. Nutrient loading from aquaculture can be significant on a local scale. A salmon farm of 200,000 fish releases an amount of nitrogen, phosphorus, and fecal matter roughly equivalent to the nutrient waste in the untreated sewage from 20,000, 25,000, and 65,000 people respectively (Hardy, 2000).

Although the Clean Water Act regulates the discharge of these kinds and volumes of wastes from other sources, including city sewage systems and concentrated animal feeding operations (CAFOs), the act's provisions have not been applied to aquaculture operations. Effluents vary based on the type of aquaculture. However, they can include not only nutrients from uneaten feed and waste products, but also antibiotics, herbicides, hormones, anesthetics, pigments, minerals, and vitamins (Goldburg et al., 2001). The containment of drugs in aquaculture is more complicated than in terrestrial livestock operations because drugs typically must be administered in water, often as components of fish feed. Therefore, the drugs are directly introduced into the surrounding environment.

In certain cases, effluents from fish farms may alter the ecosystem by changing the physical and chemical environment. These

changes affect the composition of species residing beneath netpens or downstream from facilities (NRC, 1992).

Just the physical presence of aquaculture facilities can disrupt and modify natural habitats (Goldburg et al., 2001). For example, poor siting of aquaculture facilities can obstruct wildlife use of natural surroundings.

THE ROAD AHEAD

The Commission reviewed the development of other marine industries for guidance in aquaculture. In 1976, Congress passed the Fishery Conservation and Management Act (also known as the Magnuson-Stevens Act, or MSA), a federal law that promoted the development of the U.S. commercial fishing industry. However, it provided insufficient protection for marine ecosystems. Twenty years later, when Congress was faced with a crisis in marine fisheries, it passed the Sustainable Fisheries Act to begin correcting this oversight. Today, U.S. fisheries remain in crisis, with extensive closures in formerly major fisheries. Marine aquaculture may be able to avoid the same fate as wild-capture fisheries, but only if change begins today.

We have no comprehensive government oversight to minimize ecological harm caused by marine aquaculture. This leaves us ill prepared for the industry's planned fivefold expansion. Like the MSA before it, the National Aquaculture Act of 1980 and subsequent amendments promote industry development without sufficient environmental safeguards.

Nor do we have a federal framework to govern the leasing and development of marine aquaculture farther out to sea in the U.S. EEZ—the area with the greatest potential for expansion. Jurisdiction is divided among a number of agencies: The Army Corps of Engineers presides over navigable water; the EPA over pollution; the U.S. Fish and Wildlife Service over interactions with birds; NOAA over fisheries; and the Fish and Wildlife Service and NMFS split jurisdiction over marine mammals and endangered species.

Even where its jurisdiction is clear, the federal government has been slow to provide the necessary guidance to ensure the sustainability of aquaculture. The EPA only began work on effluent guidelines, required under the Clean Water Act, as the result of a lawsuit, and has not yet developed water-quality standards for federal waters. The Army Corps of Engineers grants permits for aquaculture sites on a case-by-case basis under the Rivers and Harbors Act. However, that act lacks clear environmental standards. Although underway, guidance for the use and marketing of genetically modified organisms is also lacking.

The majority of laws and regulations that authorize, permit, or control marine aquaculture are found at the state level because most facilities are located in nearshore, state-managed waters. Few states, however, have a comprehensive regulatory plan for marine aquaculture. Notable exceptions are Maine, Hawaii, and Florida. There is no formal coordination of coastal aquaculture activity among states within a region, yet aquaculture practices in one state can affect another state's marine resources.

This complex and ineffective mix of federal and state authority over marine aquaculture is confusing, difficult for all parties—including aquaculturists—to navigate, and fails to adequately protect marine ecosystems.

As a leading importer and consumer of seafood, the United States is in a position to provide leadership on the international stage, encouraging sustainable marine aquaculture practices in other countries. A recent World Trade Organization decision upheld the U.S. prohibition of shrimp imports that are harvested without the use of equipment to protect sea turtles—a requirement that applies to U.S. shrimp fishermen. The U.S. could use this model to negotiate trade agreements that encourage sustainable marine aquaculture practices—a position that would be strengthened by the adoption of appropriate aquaculture management measures for U.S. waters.

Over the past several years, a growing body of literature has documented the impacts of aquaculture on the environment (Costa-Pierce, 2002). Federal agencies are actively developing programs to control effluents (EPA, 2000) and to guide offshore aquaculture development (DOC, 2000). The United Nations Food and Agriculture Organization developed Codes of Conduct for Responsible Fishing, which include guidance for aquaculture development.

The time is pivotal to provide the guidance and tools for this industry to grow in an ecologically sustainable fashion. The U.S. should develop a proactive national marine aquaculture policy that protects marine ecosystems and provides international leadership by promoting sustainable aquaculture practices worldwide.

SUMMARY OF RECOMMENDATIONS

1. Implement a new national marine aquaculture policy based on sound conservation principles and standards.

Congress should enact legislation to regulate marine aquaculture pursuant to sound conservation and management principles. The legislation should establish national standards and comprehensive permitting authority for the siting, design, and operation of ecologically sustainable marine aquaculture facilities. The lead authority for marine aquaculture should reside in the proposed national oceans agency or the National Oceanic and Atmospheric Administration.

Until national marine aquaculture standards and policy are established, the administration or Congress should place a moratorium on the expansion of marine finfish farms. Likewise, until an adequate regulatory review process is established, the government should place a moratorium on the use of genetically engineered marine or anadromous species.

2. Provide international leadership for sustainable marine aquaculture practices.

The United States should negotiate and work with other nations to establish environmental provisions in international trade agreements to encourage ecologically sustainable marine aquaculture practices in the international community.

Chapter Seven
BEYOND OUR BORDERS

Bluefin tuna, Baja California
Richard Herrmann

Let us be good stewards of the Earth we inherited. All of us have to share the Earth's fragile ecosystems and precious resources, and each of us has a role to play in preserving them. If we are to go on living together on this Earth, we must all be responsible for it.

Kofi A. Annan
Secretary-General of the United Nations
An excerpt from Mr. Annan's 2001 message for World Environment Day, a worldwide annual celebration that recognizes the commencement of the United Nations Conference on the Human Environment.

All life depends on healthy ecosystems. As the human population soars toward 8 billion, we are placing an increasing and unsustainable strain on our natural resources. The strain is reflected in growing conflicts—fishermen competing for ever fewer fish, states fighting over water and land rights, oil carefully guarded. The more we deplete our living natural resources, the closer we come to crossing thresholds of irreversible damage to those resources and to the ecosystems that produce and sustain them.

How many fish can be removed from a population before it collapses? How many populations can collapse before a species goes extinct? What repercussions will such extinctions have on other marine species, on human communities, and on nations connected by trade? Scientists warn of the danger of crossing these thresholds in marine ecosystems. Once we do, we cannot go back easily, if ever.

The declining health of the oceans is a global concern that requires international action. Therefore, cooperation at the international level is critical to our efforts to address this issue of "natural security." In September 2002, this sentiment was clear at the World Summit on Sustainable Development in South Africa, which called for important steps to be taken by all nations to protect the world's oceans. A Plan of Implementation was agreed upon that calls for the elimination of destructive fishing practices and subsidies that promote illegal fishing and overcapacity, the establishment of marine protected areas and sustainable fishing limits, reduction of pollution and environmental damage caused by ships, and increased monitoring and use of environmental impact assessments.

The Pew Oceans Commission, though charged with a review of U.S. ocean policies, recognizes the international nature of the crisis facing our oceans and believes that the United States must demonstrate leadership in the area of marine protection. We have the largest Exclusive Economic Zone in the world, with a footprint that stretches across the Pacific Ocean; what we choose to do in our waters invariably affects the condition of the global oceans, and our interests are readily affected by the actions of others. Many of the Commission's recommendations—to protect fisheries, reduce the flow of pollution into coastal waters, and preserve coastal habitat—require action at home and abroad. Only through strong leadership in the care of our own waters can the U.S. assert moral authority to ensure greater protection of marine resources abroad.

RATIFY CRITICAL INTERNATIONAL CONVENTIONS

As first and critical steps, the Commission recommends that the United States ratify the 1982 United Nations Convention on the Law

of the Sea (UNCLOS) and the 1992 Convention on Biological Diversity.

UNCLOS, which entered into force in November 1994, is the legal foundation upon which international ocean resource use and protection is built. It addresses fundamental aspects of ocean governance, including delimitation of ocean space, environmental control, marine scientific research, economic and commercial activities, transfer of technology, and the settlement of disputes relating to ocean matters. U.S. ratification would serve to codify President Ronald Reagan's establishment of a 200-mile Exclusive Economic Zone for the United States. As of October 2002, 138 countries had ratified it.

The Convention on Biological Diversity is the premier international legal instrument devoted to biodiversity and ecological sustainability. It was signed by more than 150 governments at the U.N. Conference on Environment and Development in June 1992, and entered into force the following year. As with UNCLOS, the U.S. has signed, but not ratified, this convention.

HIGHLY MIGRATORY SPECIES

The health of highly migratory species in U.S. waters depends on careful domestic management coupled with protection by the international community beyond our jurisdiction. The U.S. has taken steps at home and in global forums to protect species such as marine mammals, turtles, seabirds, and tuna. In the late 1990s, the federal government used U.S. conservation standards as leverage in negotiating international dolphin and sea turtle conventions aimed at reducing bycatch. In the case of sea turtles, the World Trade Organization ruled that the U.S. could impose trade sanctions on countries whose shrimp fisheries did not protect sea turtles as well as our domestic fisheries.

In 2000, after a six-year effort by the United States and involving 33 Asian and Pacific nations, the U.S. signed the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. This convention, which recognizes the economic importance of the fisheries to the people of the Pacific Islands, includes strong provisions for minimizing the negative impacts of fishing and for protecting biodiversity. The United States should vigorously implement and fully fund its share of the operating budget for this Convention.

These are important steps for the protection of highly migratory species, but more remains to be done, including implementation of the United Nations Agreement relating to the Conservation and Management of Straddling and Highly Migratory Fish Stocks and improving implementation and enforcement by the International Commission for the Conservation of Atlantic Tunas (ICCAT).

PERSISTENT ORGANIC POLLUTANTS

The U.S. has signed the Stockholm Convention on Persistent Organic Pollutants (POPs), which bans the manufacture and sale of twelve of the most harmful toxic chemicals. The treaty addresses both manufacturing of persistent organic pollutants and their release through incineration or leaking. The Commission recommends U.S. ratification of this treaty with a mechanism for adding new toxic substances as necessary for the protection of human health

Bill Harrigan/The Waterhouse

Photo © www.brandoncole.com

A coral reef in Florida teems with life (above). Coral reefs support amazing biodiversity, rivaling that of tropical rain forests. Reefs are in decline worldwide due to overfishing, pollution, sea-level rise, coastal development, and bleaching (right) which is caused by rising sea-surface temperatures.

and the environment. We must also work with other countries to reduce the long-distance transport of heavy metals and other contaminants.

SETTING THE EXAMPLE

In order to meet its responsibilities toward its ocean resources, the U.S. will need the assistance of the community of nations. The Commission believes, however, that this nation must get its own house in order first to provide a solid foundation upon which to lead internationally. By establishing appropriate standards for sustaining marine species and ecosystems, the U.S. will be in a better position to use trade pressures—as it did successfully to protect sea turtles from unsustainable shrimp fisheries—or participate credibly in negotiations of ocean resource treaties. For example, only by adopting strong conservation standards for its domestic aquaculture industry can the U.S. establish the moral and legal authority to demand protective practices in other countries.

In some cases, unilateral efforts cannot adequately protect U.S. marine resources. Protecting our coastal ecosystems from invasion by some of the thousands of species carried in the ballast-water tanks of oceangoing vessels is a good example. It is truly a global problem; uniform standards to prevent harmful ballast-water discharge must be put in place and enforced by all nations. The International Maritime Organization is currently drafting language for an international ballast-water management regime. The proposed convention would require control of ballast water and sediments contained in ballast tanks. Though unilateral action might not adequately protect U.S. waters, strong domestic requirements for ballast-water treatment would greatly strengthen our position in ongoing international negotiations.

All nations of the world must examine their ocean policies. If we are to restore the

world's fisheries, reduce pollution, protect marine habitats, and sustain coastal communities, it is time to acknowledge the international dimension of ocean resource protection, and to engage U.S. policymakers and citizens—and the international community—to find solutions.

The first step is ours to take.

WILD CARD OF CLIMATE CHANGE

Global air temperature is expected to warm by 2.5 to 10.4°F (1.4 to 5.8°C) over the 21st century, affecting sea-surface temperatures and raising the global sea level by 4 to 35 inches (9 to 88 cm) (IPCC, 2001). Such climate change will create novel challenges for coastal and marine ecosystems already stressed by overfishing, coastal development, and pollution.

Based on observations, scientists expect that this rapid climate change will result in the extinction of some species and serious, if not catastrophic, damage to some ecosystems. Important coastal and ocean habitats, including coral reefs, coastal wetlands, estuaries, and mangrove forests will be particularly vulnerable to the effects of climate change. These systems are essential nurseries for commercial fisheries and support tourism and recreation. Wild fisheries and aquaculture will be affected as well. Climate change will modify the flow of energy and cycling of materials within ecosystems—in some cases, altering their ability to provide the ecosystem services we depend upon.

We know that climate change is no stranger to Earth. Since life began, ice ages and hot spells have affected the distribution of organisms as well as their interactions. However, today human activities that increase the emission of greenhouse gases, such as carbon dioxide, methane, and nitrous oxide, are spurring changes with a rapidity rarely experienced in Earth's history. Such high rates of change bring with them great unpredictability.

In August 2002, The Pew Center on Global Climate Change completed a report entitled *Coastal and Marine Ecosystems and Global Climate Change: Potential Effects on U.S. Resources* (Kennedy et al., 2002). It identifies the critical implications of climate change on the coastal zone and open ocean.

The authors of this report drew a number of conclusions, which we summarize below.

Coral reefs are at particular risk from global climate change.

Recent episodes of bleaching and high mortality of coral animals have been linked to higher temperatures. Although coral reefs are capable of recovery from bleaching events, prolonged or repeated bleaching can lead to mortality. Recent estimates suggest an increase in mean sea-surface temperature of only 2°F (1°C) could cause the global destruction of coral reef ecosystems (Hoegh-Guldberg, 1999).

Sea-level rise also poses a potential threat to coral reefs, which need the light that penetrates relatively shallow water. The problem of sea-level rise is likely to be made worse by the effects of increased atmospheric CO_2 on marine chemistry. A doubling of atmospheric CO_2, for example, could reduce coral-reef calcification (i.e., growth) by 20 to 30 percent (Kleypas et al., 1999). Although in the past, corals have been able to build their reef masses upward to keep up with rising sea levels, such slowdowns in growth induced by climate change could result in

many reefs losing this race.

Increased coastal erosion associated with sea-level rise could also degrade water quality near coral reefs by increasing turbidity and sedimentation. Many coral reefs are also vulnerable to other human and natural stressors, such as coastal development, overfishing, pollution, and marine disease.

Global climate change is predicted to affect precipitation, wind patterns, and the frequency and intensity of storms.
These environmental variables are crucial to the structure, diversity, and function of coastal and marine ecosystems. The increase in air temperature will directly affect sea-surface temperatures and accelerate the hydrological cycle (IPCC, 2001). Unequal heating and cooling of the Earth's surface drive much of the world's winds. The winds could be altered by surface warming, affecting wind-driven coastal and marine currents. Although the impact of climate change on tropical storms and hurricanes remains highly uncertain, maximum wind speeds could increase by 5 to 20 percent (Knutson and Tuleya, 1999; Henderson-Sellers et al., 1998).

Warming temperatures will influence reproduction, growth, and metabolism of many species in stressful or beneficial ways, depending on the species.
In any particular region, some species could decline while others thrive. Warmer temperatures tend to enhance biological productivity, which could benefit some U.S. coastal ecosystems, at least over the short term. However, increases in temperature tend to increase the metabolic rates of organisms, leading to greater oxygen demands. At the same time, warmer water holds less oxygen than cooler water. Therefore, low oxygen conditions—which already afflict many coastal areas polluted by excess nutrients washed off the land—may worsen.

Climate change has the potential to benefit and to harm aquaculture.
Aquaculture could potentially benefit from climate change, as warmer temperatures tend to increase growth rates. Warming oceans could also allow the culturing of species in areas that are currently too cold.

However, warmer temperatures could also limit the culturing of some species. Summer mortality is often observed among cultivated Pacific oysters on the U.S. West Coast, which could be exacerbated by climate change. Warmer temperatures may increase the risk of marine disease among cultured (as well as native) species (Harvell et al., 2002).

The implications of climate change for U.S. aquaculture will likely be heavily dependent upon the industry's ability to adapt its operations to suit the prevailing climate.

Temperature changes will drive species migration and could change the mix of species in particular regions.
Higher temperatures would be lethal to some species at the southern end of their range and would allow others to expand the northern end of their range, if they were sufficiently mobile. The geographic range of Pacific salmon, for example, is sensitive to changes in climatic conditions. Warm waters in the northern

Pacific have historically been associated with a shift in salmon production from the coast of the Pacific Northwest to Alaska's Bering Sea (Mantua et al., 1997; Hare et al., 1999). Similarly, warm-water fish species on the U.S. East Coast expanded north of Cape Cod during the 1950s in response to warmer sea-surface temperatures (Taylor et al., 1957).

Thus, climate change in this century is likely to drive similar changes in species distributions, with some species contracting their ranges and others expanding. This would lead to different mixes of species that could affect predator-prey relationships, species competition, and food web dynamics. In addition, it could drive the proliferation of invasive species, including marine diseases (Harvell et al., 2002).

Because many of our coastal communities depend upon marine species for their economic livelihood, redistribution will most certainly disrupt economies. However, it is impossible to predict how this will affect specific fisheries.

Sea-level rise could threaten the survival of marshes and mangroves.
As sea level rises, coastal marshes have the inherent ability to accrete (i.e., grow) vertically through the deposition of sediment carried downstream by rivers and streams. However, climate change is likely to change patterns of rainfall and runoff, which could limit sediment availability. Furthermore, human modifications of rivers and streams (e.g., dams) already limit sediment delivery in many areas, such as the wetlands of southern Louisiana (Cahoon et al., 1998). Continuation of this practice could limit the ability of wetlands to keep pace with rising sea levels.

Other human adaptations to climate change, such as the construction of seawalls to hold back the sea, could block inland migration of wetlands. Gradually, the wetlands would be inundated by rising seawater. They and their ecological services would be lost over time.

Changes in precipitation could flood coastal systems or leave them in drought.
Changes in precipitation would affect runoff from land, and stratification of the water column, which affects oxygen concentrations in deep water. These changes also affect water circulation patterns and associated delivery of juvenile organisms to nursery areas. In concert with sea-level rise, increased runoff from land would shrink estuarine habitats, diminishing their ability to support coastal animal and plant populations.

Increased runoff could also increase the delivery of nutrients and toxic chemicals into coastal ecosystems near urban communities. This would degrade water quality and increase the risk of harmful algal blooms. Regional fishing, hunting, and ecotourism enterprises could all be affected.

Reductions in freshwater input could also increase the salinity of estuarine systems, limiting productivity and biodiversity. Permanent reductions of freshwater flows could contribute to major reductions of biological productivity in alluvial bay systems, such as Gulf Coast lagoons.

Changes in wind patterns could affect coastal and estuarine circulation patterns and upwelling and downwelling of water in marine systems.

Young organisms of many species, such as blue crab, menhaden, and bluefish, are transported into or out of estuaries by wind-driven, nearshore circulation patterns (Epifanio and Garvine, 2001). Changed patterns would affect the normal life cycle of these species, and could diminish, if not eliminate, local populations.

In addition, wind patterns are important drivers of coastal upwelling, which provides needed nutrients to some regions. Diminution of this upwelling could reduce the ocean's productivity in these coastal areas. In contrast, increased productivity should occur in those areas that experience increased upwelling.

Changes in the frequency and intensity of storms could increase flooding and threaten coastal aquaculture and fishing industry facilities.

Storm events are major drivers of coastal erosion. In addition, hurricane landfalls on the East Coast and in the Gulf of Mexico have historically been associated with significant coastal flooding. Hurricanes Dennis, Floyd, and Irene cumulatively led to 50- to 500-year floods in North Carolina during 1999. In addition to their impact on humans, these floods delivered large amounts of nutrients to the estuaries that caused oxygen depletion and harmful algal blooms (Paerl et al., 2001).

Coastal aquaculture facilities are also highly vulnerable to the high winds and storm surges associated with coastal storms. Although the effects of climate change for storm events remain uncertain, the possibility of increased storm intensity is a significant concern.

Natural climate variability, such as El Niño events, results in changes in open-ocean productivity, shifts in the distribution of organisms, and modifications in food webs, foreshadowing what would happen if climate change accelerated.

Natural climate variability exists independent of anthropogenic climate change, but may act in tandem with (or opposition to) anthropogenic climate change. The consequences are difficult to predict. Climate change could increase the frequency, duration, and/or severity of El Niño events, which have important ecological effects, heightening impacts on human society. In particular, El Niño events are often associated with mass coral bleaching, which threatens the long-term sustainability of these ecosystems (Wilkinson, 2000).

Over the coming century, changes in temperature or salinity of North Atlantic water in the Arctic may slow or shut down the slow-moving thermohaline circulation that delivers cold, dense, oxygenated water to the deep sea.

This would affect delivery of oxygen and nutrients from the ocean surface to the deep ocean in coming centuries, with unknown consequences for communities of deep-sea animals.

In addition, this change in circulation could alter the distribution of heat throughout the waters and atmosphere of the North Atlantic, which would affect the geographic distribution of fisheries.

It is possible that other such climate surprises could manifest in response to climate change, resulting in rapid, unpredictable changes in the marine environment.

Climate-induced changes in ocean chemistry could diminish the abundance of microscopic open-ocean plants and animals.
Model results indicate that a doubling of the preindustrial atmospheric concentration of atmospheric carbon dioxide (currently projected to occur by the middle of the 21st century) could reduce the amount of calcium carbonate in ocean waters by 30 percent (Gattuso et al., 1999; Kleypas et al., 1999). This would limit the growth and abundance of calcium carbonate-dependent organisms. Some of these highly abundant organisms, such as diatoms and dinoflagellates, produce a chemical (dimethyl sulfide) that ultimately helps to cool surface air temperatures. Thus, changes in calcium carbonate chemistry could indirectly reinforce global warming. Our knowledge of these interactions is rudimentary, making it difficult to predict the consequences of any chemical changes.

BOX ONE

Steve Simonsen/Marine Scenes

ADDRESSING THE EFFECTS OF CLIMATE CHANGE ON OUR OCEANS

The potential effects of climate change offer compelling justification for improvements in the protection and management of marine resources.

Independent of anthropogenic activities, climate has a profound influence on the structure and function of marine ecosystems. As such, changes in climate (whether natural or anthropogenic) are likely to significantly alter these ecosystems—a process that is already underway (Parmesan and Yohe, 2003; Root et al., 2003). Failure to account for these changes will compromise management efforts.

Climate change is likely to be an additional stress to marine ecosystems, beyond more traditional concerns, such as pollution, development, and overfishing. Climate change will interact with these stressors in unpredictable ways (i.e., additively, synergistically, antagonistically) to influence the future of U.S. marine resources.

The recommendations of the Pew Oceans Commission, if implemented, would address current challenges to U.S marine resources, and would reduce the adverse effects of future climate change. The adaptive and cautionary management approach advocated throughout this report is, in essence, the Commission's climate change response action plan. Recommendations for fisheries, coastal development, pollution control, and governance are all based on the need for a better understanding of, and management focused upon, coastal and marine ecosystems and all the factors that influence them. Clearly, changing climate is among the most significant long-term influences on the structure and functioning of those systems, and must be accounted for to ensure healthy and productive ocean environments. Healthy ecosystems are also more resilient to all perturbations, including climate-induced changes.

The Commission feels strongly that the U.S. and its global neighbors must do the one thing that can directly limit the effects of climate change on the marine environment—reduce our emissions of greenhouse gases that contribute to this problem. Only then can we assure coming generations and ourselves that the recommendations we offer will yield the bountiful seas we envision.

Chapter Eight
SCIENCE, EDUCATION, AND FUNDING

Near Cape Kumakahi, Hawaii
Ron Dahlquist/rondahlquist.com

Science must play a key role in advancing marine ecosystem management that is integrated, precautionary, and adaptive.

Donald F. Boesch and others, 2001
Marine Pollution in the United States: Significant Accomplishments, Future Challenges

Living oceans cover about 71 percent of the Earth's surface. They are inextricably linked with the land and atmosphere. Ocean currents circulate the energy and water that regulate the Earth's climate and weather. Thus, the oceans affect every aspect of the human experience. From surface to seafloor the world's oceans contain nearly 100 times more habitable space than terrestrial ecosystems. The life supported in this vast realm is believed to reflect genetic, species, habitat, and ecosystem diversity that exceeds that of any other Earth system. The natural wealth of these systems provides valuable ecosystem services, commodities, and other social and economic benefits. Incredibly, the oceans are the least studied and understood of the Earth's natural endowments.

There has never been a more critical time for the nation to increase its investment in ocean science and research. We know the oceans are in crisis. Unfortunately, as the nature, scale, and complexity of threats to marine ecosystems have increased, our national investment in ocean science and research has stagnated. For more than a decade, federal spending on ocean sciences has hovered near 755 million dollars annually—less than four percent of the nation's annual expenditure for basic scientific research. The consequences of this underinvestment are striking. We know

- we need to maintain healthy ecosystems to sustain the benefits they provide society, but we often lack baseline information about the history and status of those systems upon which to base management decisions;
- human-induced extinctions are occurring in the oceans, but we have little idea of their scope because virtually all of our data collection focuses on the relatively small handful of commercially valuable species (Carlton et al., 1999);
- we must prevent overfishing, minimize bycatch, and protect habitat to sustain our fisheries, yet we have not assessed the status of two-thirds of our managed fish stocks, we fail to collect bycatch data in two-thirds of federally managed fisheries, and we remain largely ignorant about the habitat requirements of most valuable fishery species;
- toxic pollution can harm individual animals and biologically significant contamination occurs throughout the nation's coastal waters, but our understanding of population-level and ecosystem-level impacts is poor.

A NATIONAL COMMITMENT TO INCREASING SCIENTIFIC CAPACITY

Forty years ago, our nation made a commitment to space exploration. Today, we know more about the surface of the moon and other planets than we do about the oceans. In the late 1980s, we made a 4.5-billion-dollar commitment to modernize the National Weather Service with integrated observational

systems. Today, our enhanced ability to predict weather patterns helps to ensure public safety. We committed these resources because we believed that high stakes justified the investment. The stakes could not be higher now in understanding and caring for the oceans. The nation must increase investment in ocean science and research, particularly broader ecological monitoring programs and investigations.

To support this endeavor, the Commission recommends that Congress at least double funding for basic ocean science to 1.5 billion dollars annually, or approximately seven percent of the basic federal research budget.

At the core of this financial commitment is a quest for knowledge that can help to sustain the health, biodiversity, productivity, and resilience of marine ecosystems for future generations. We need a deeper understanding of the effects of both natural and anthropogenic change on marine ecosystems as well as of the ocean's interaction with terrestrial ecosystems and the atmosphere.

COLLECTING AND APPLYING NEW INFORMATION

Increased capacity is needed in four areas to improve applied ocean science and research:

1. acquisition of new information, knowledge, and understanding;
2. monitoring to evaluate status and trends;
3. capability to integrate and synthesize existing and new information;
4. sharing of information and knowledge with the public.

Scripps Institution of Oceanography

High seas wash onto the deck of Scripps Institution of Oceanography's research vessel New Horizon *as scientists work to retrieve a large buoy. The 1,800-pound buoy is anchored to the seafloor by a cable that has instruments to measure underwater currents and temperature at various depths.*

For more than a decade, federal spending on ocean sciences has accounted for less than four percent of the nation's science budget. The Commission recommends a doubling of the federal ocean research budget.

To adequately describe ecosystems, characterize their threats, and manage for their restoration, we need new cross-disciplinary scientific programs. Various combinations of expertise—of fishery scientists, marine ecologists, oceanographers, climatologists, marine mammal and seabird biologists, anthropologists, economists, sociologists, and historians—can further our understanding.

We need to know as much about people and economics as we do about the biology and ecology of living marine resources and ecosystems. Complex interactions between human and environmental systems must be better understood. Cooperative research involving the fishing industry and native communities, that offer valuable experiential and traditional knowledge, should be a central element of a number of these new scientific programs.

Given that many coastal and marine ecosystems have already suffered high levels of degradation, the Commission recommends

the nation embark on a major commitment to develop the relatively new science of marine restoration ecology.

Monitoring of both human and natural systems must also be increased. Comprehensive ecosystem monitoring programs such as the California Cooperative Oceanic Fisheries Investigation, the Global Ocean Ecosystem Dynamics Program, the Gulf of Maine Ocean Observing System, and the Gulf of Alaska Ecosystem Monitoring Program should be expanded, strengthened, and replicated.

A national fishery observer program should be implemented—employing appropriate, effective alternative monitoring schemes where necessary (e.g., on smaller boats that cannot safely accommodate an observer)—accompanied by vessel monitoring systems and electronic data reporting for real-time data management. Social and economic assessment and monitoring programs for human systems—the behavior of people, communities, and institutions—must be increased.

We need new research and monitoring programs to improve the timely collection, compilation, and analysis of data. An improved ability to integrate and synthesize information will allow scientists to more accurately predict the consequences of different courses of action. This involves developing the next generation of ecosystem models that incorporate the influences of trophic interactions, environmental variability, and human activity. Finally, new scientific programs should utilize adaptive management to assess results, learn from experience, and adjust incentives, regulation, and management accordingly.

IMPROVING THE USE OF EXISTING INFORMATION

Too often the institutions responsible for managing our marine resources fail to adequately use existing scientific understanding in the decision-making process. Improving how existing information and knowledge is used is the first and most important step to improve the scientific foundation for ocean and coastal management.

Uncertainty will always be a defining characteristic of ecosystem-based management, just as it has been for single-species management. Although some uncertainty can be reduced with increased monitoring and research, a degree of uncertainty is unavoidable because of the dynamic and complex nature of marine ecosystems and the many influences upon them. Thus, decisions about marine ecosystems should take into account the risks inherent in making incorrect decisions.

The Commission believes this is best accomplished by incorporating the precautionary approach as a core principle of national ocean policy. In cases where information is uncertain or inconclusive, the need to protect, maintain, and restore the health, integrity, productive capacity, and resilience of marine ecosystems should always be the top priority for managers. This guiding philosophy is intended to prevent irreversible changes to marine ecosystems as a result of over-exploitation or habitat destruction.

The Commission also believes that to assure the independence and integrity of scientific advice, scientific work needs to be insulated from political and economic pressures. This may require reorganizing the institutional relationship between scientific research and

resource management in some programs (for more detailed discussions of this concept, see Sissinwine and Mace, 2001; Hutchings et al., 1997). Nowhere is this need more evident than in fisheries management, where the Commission recommends separating science-based conservation decisions from economic and political allocation decisions.

The creation of a mechanism or institution to provide independent scientific oversight would help ensure that scientific advice provided to ocean resource managers is comprehensive and current.

The Commission further recommends that a comprehensive ocean research and monitoring strategy be developed and implemented by the national oceans council, the establishment of which the Commission recommends in Chapter 2.

NEW ERA OF OCEAN LITERACY

If we are to succeed in implementing a new national ocean policy to restore and maintain ocean ecosystems, we will need more than new laws and institutions. We must build a national constituency for the oceans that includes all Americans, whether we live along the coast or in the Rocky Mountains. We must prepare today's children to be tomorrow's ocean stewards.

The Pew Oceans Commission calls for a new era of ocean literacy that links people to the marine environment. Through enhanced marine education and awareness, we can inspire the next generation of scientists, fishermen, farmers, business and political leaders—indeed all citizens—with a greater understanding and appreciation for the oceans.

Franklin Viola/violaphoto.com

A mother and her young son experience the wonders of marine life at Hanauma Bay, Hawaii. The Pew Oceans Commission calls for a new era of ocean literacy that prepares today's children to be tomorrow's stewards.

The federal government is only one part of this effort. As the Commission traveled around the country, it saw people across all levels of government and in many professions promoting ocean literacy.

During the Commission's visit to Charleston, South Carolina, Mayor Joseph Riley and fellow commissioners joined students from Memminger Elementary School to learn about sharks. Using a live link with scientists from Mote Marine Lab in Florida, students were able

Deb Antonini/Pew Oceans Commission

Mayor Joseph Riley (above) participates in a discussion about sharks with students from Memminger Elementary School during the Commission's visit to Charleston, South Carolina.

to learn about some of the myths associated with sharks and the threats to their survival.

During the Commission's visit to Hawaii, several commissioners appeared on the public education television program, *KidScience*. They met schoolchildren learning about the oceans and offering their solutions to the problems of pollution, habitat loss, and overfishing. To build on that experience, the Commission collaborated with *KidScience* on a four-part, nationally televised program that brought the oceans into thousands of classrooms across the country, with links to the South Carolina Aquarium, the Aquarium of the Americas in New Orleans, and the Monterey Bay Aquarium.

The Commission's experiences point to an important opportunity to use the ocean world to advance public scientific understanding in such disciplines as biology, chemistry, physics, geology, mathematics, and engineering. We saw outstanding examples of aquariums and science centers helping the public connect with the marine world. In California alone, the major aquariums attract as many as six million visitors each year.

Restoring and sustaining the oceans require broad public support. This support begins with greater awareness of just how valuable—and vulnerable—the oceans are. It is time to make a nationwide commitment to teach and learn about our oceans.

The Commission encourages greater collaboration among all levels of government and partnerships between the public and private sectors to provide teachers with the materials and training they need to bring the oceans into the classrooms. The Commission urges the national oceans agency to take a stronger role in building ocean literacy throughout the country, similar to NASA's outer space education programs. The Commission challenges academic institutions to increase enrollment in ocean sciences at the postgraduate levels. It supports the ongoing efforts of aquariums and science centers to connect the public with the ocean realm and instill greater awareness for the public's role in ocean protection.

With all other concerned citizens, the Commission welcomes a new era of ocean literacy.

FUNDING GOOD OCEAN GOVERNANCE

Relative to the size of the public's ocean domain and to its value to society, the United States has substantially underinvested in understanding and managing our oceans. In fiscal year 2001, the United States spent a little more than 3 billion dollars to manage natural resources in 4.5 million square miles of U.S. ocean waters, an area 23 percent larger than the landmass of the United States. By contrast, the federal government spent more than 10 billion dollars to manage the one million square miles of federal public lands—and their natural resources—in the same year.* We are now spending 14 billion dollars every year on space exploration, but a

*Consists of the fiscal year 2001 budgets of the Bureau of Land Management, Fish and Wildlife Service, National Park Service, and the U.S. Forest Service, with funding for state and private forestry initiatives backed out. This figure is conservative because it does not include the substantial expenditures for management of public lands administered by the Department of Energy, Department of Defense, and other agencies.

plan recommended by a blue-ribbon panel calling for 75 million dollars per year for ocean exploration has so far been funded at only 4 million dollars annually.

In this report, the Commission urges the nation to adopt a new national ocean policy based on precaution, ecologically sustainable use of marine resources and habitats, and management on a regional ecosystem basis. It recommends new laws and institutions, better implementation of existing law, and expanded scientific research. None of this can happen without a substantially greater financial commitment. If properly executed, this investment will be paid back in the form of abundant living ocean resources, prosperous fishing communities, and clean coastal oceans. For example, data compiled by the National Marine Fisheries Service indicate that restoring our fish stocks could yield an additional 1.3 billion dollars annually from the increased supply of seafood alone. Without an increased financial commitment to our oceans, we risk further decline in ocean ecosystem health and serious consequences for human well-being far into the future.

George Grall/National Geographic Image Collection

Gulls near Cape Charles, Chesapeake Bay

A SENSE OF SCALE

It is difficult to estimate how much all this will cost. Current coastal ecosystem restoration efforts around the country provide some sense of scale. The effort to partially restore the Florida Everglades, for example, is estimated to cost at least 7.8 billion dollars over the life of the project, half of which would be federal funds. A nascent effort to reduce land loss in the Mississippi River Delta is estimated to cost 14 billion dollars. The estimated cost to restore California's Sacramento River Delta is 20 billion dollars. The Chesapeake Bay Program receives about 25 million dollars annually from the federal government, with the participating states contributing more than 100 million dollars each year for various programs related to the health of the bay. Yet, this program barely holds its own with the continued growth and development of the Chesapeake Bay watershed.

Another approach to estimating costs is to look at the number of areas likely to need some degree of restoration. A 1999 study by NOAA looked at 138 estuaries along the coast of the conterminous United States and found that 44 estuaries exhibited signs of eutrophication and another 40 estuaries had moderate degradation. If Chesapeake Bay is an indicator, it will likely cost in the range of 10 to 100 million dollars annually to address the complex interactions of overfishing, land use, and point and nonpoint source pollution that lead to coastal environmental degradation in

Kip F. Evans/National Geographic Society

Scientist and crew from the NOAA ship McArthur *deploy a DeepWorker submersible for an exploratory mission in the Gulf of the Farallones National Marine Sanctuary.*

each estuary. Picking a conservative value of 10 million dollars per year per estuary, it would require about a billion dollars annually just to address eutrophication in the lower 48 states. Additional investment will be required to prevent degradation of coastal and ocean waters that are currently relatively pristine.

Based on the scope and the scale of ocean and coastal environmental problems, the Commission estimates the need for at least an additional 2 to 5 billion dollars annually to

- establish regional ocean governance councils;
- assess the status of large marine ecosystems;
- develop and implement regional ocean governance plans;
- coordinate with ongoing programs at all scales;
- undertake habitat protection and restoration on the scale needed to restore and maintain the health of our oceans and coasts.

The Commission also recommends a doubling of our nation's commitment to marine research, which would require an additional 800 million dollars annually.

The Commission recommends that initial expenditures include an increase in the NOAA budget from 3 billion dollars to 6 billion dollars over the next five years. This increase should allow NOAA to provide the regional ocean ecosystem councils with 1 to 2 billion dollars annually. The regional ecosystem councils should use these funds for monitoring, assessment, and characterization of marine ecosystems, developing and implementing comprehensive regional ocean governance plans, and coordinating among all levels of government with jurisdiction over activities affecting the oceans.

In addition, significant increases in funding will be needed for interagency coordination and consultation to ensure that the federal government is carrying out the National Ocean Policy Act.

PAYING FOR IT

Because it is in the national interest to protect, maintain, and restore our oceans, it is appropriate that the federal government pay a significant share of these costs. However, the states must also participate, as they will share in the benefits of healthy marine ecosystems. The main source of new federal funding will probably be general revenue. However, revenue-generating programs that specifically address ocean-related industries and services can also be put in place.

The establishment of a permanent, dedicated federal fund for habitat protection,

restoration, and wildlife conservation would provide a much-needed supplement to annual appropriations for protecting and enhancing coastal ecosystems. Congress is currently considering proposals that would provide states and local jurisdictions with more than 3 billion dollars annually for wildlife conservation, habitat protection, and other activities. The Commission feels that funding of this type could pay for a substantial portion of state and local activities required to protect and restore our oceans and coasts, but that Congress should structure this funding in a way that does not provide incentives for new offshore oil and gas activity.

Additional revenue to offset the costs of managing fisheries and other living marine resources could be derived from a variety of possible sources. One approach is to require some form of payment by the private users of public ocean resources. When public access to a fishery will be limited, as in fisheries managed by individual quotas, seeking some form of compensation for access to the resource is particularly attractive. One approach is to auction quota shares for limited-access fisheries based on royalty bids. Auctions based on a percentage of value of the actual catch (a royalty) requires no cash up front, is self-correcting for poor fishing seasons, and could be structured to allow family fishermen to remain competitive in the bidding process.

Another approach is to collect resource rents through some form of landings tax. The state of Alaska assesses a tax on processors of Alaska seafood that generated 32.5 million dollars in 2002 (ADR, 2002). The tax rate varies between one and five percent of the value of unprocessed fish, depending on the fishery and the type of processing. In 2000, commercial landings from all U.S. fisheries were valued at 3.5 billion dollars. Thus, a one percent tax on commercial landings would generate 35 million dollars in revenue.

To ensure that the revenue generated from the public resource is reinvested in that resource, any revenue generated by collecting rents, royalties, or taxes on seafood should be deposited in a permanent, dedicated fund for fisheries conservation, research, and management.

Fees collected for use of ports and shipping channels presents another possible revenue-generating mechanism. The maintenance of ports and shipping channels, while of great economic value to the nation, has substantial environmental costs. Additional fees should be paid by the shipping industry to address these impacts on the coastal environment. The Harbor Maintenance Tax has for many years generated substantial revenue for port and channel maintenance and deepening. This tax (sometimes referred as a "fee"), which is collected on the value of maritime cargo passing through our ports, has been curtailed after collecting the tax on exports was found to be unconstitutional. The European Union is now challenging its application to imports as a discriminatory trade practice.

A new channel maintenance fee based on the draft of vessels, which ultimately drives channel-deepening efforts, could be devised to provide a significant, and legal, source of funding. Such fees could make channel-deepening projects, where needed, self-financing, and provide an ongoing source of revenue for environmental mitigation and enhancement.

INCENTIVES MAKE SENSE

In the chapters on coastal development and pollution, the Commission has recommended that the current structure of federal development and agricultural subsidies be examined to ensure that federal dollars are not exacerbating damage to coastal ecosystems. Specifically, the Commission recommends that federal funds for agriculture, highway construction, and other development should be contingent on progress toward compliance with the Clean Water Act. But this approach should not be based solely, or even primarily, on disincentives. The substantial subsidies provided in these areas should be increasingly redirected toward positive actions.

Many positive changes are already taking place, such as enhancements to habitat protection and restoration programs in the Farm Bill. The Water Resources Development Act, which funds Army Corps projects, should devote increased funding to prevent and restore environmental damage. The Transportation Equity Act of 2001 has provided flexibility for states and municipalities to reduce automobile dependency and mitigate impacts of transportation projects. The reauthorization of this legislation provides opportunities to link transportation funding with improvements in land use and water quality. States should be given greater flexibility to use state revolving-fund money under the Clean Water Act to reduce polluted runoff. These are just a few examples of how long-established spending patterns and programs can be shifted to provide substantial capital for environmental restoration and protection.

We have done great damage to our oceans and coasts, and we now know that environmental damage imposes substantial real costs to society in the form of lost ecological and economic goods and services. Repairing this damage will not be easy or inexpensive, but it is incumbent on this generation to repair the damage done by it and its predecessors so that future generations are not forced to bear that burden.

Tom & Pat Leeson

Although protected from hunting that nearly drove them to extinction, sea otters face threats from coastal pollution, habitat disturbances, and the ripple effects of overfishing on ocean food webs.

Chapter Nine
CONCLUSION: CHARTING A NEW COURSE

Point Sur Lighthouse

Over the past two years, the Pew Oceans Commission has heard from thousands of Americans from Maine to Hawaii, the Gulf of Mexico to Alaska. We have considered the latest scientific information regarding our oceans. In the midst of unease and even alarm about our oceans, we have heard expressions of hope and seen signs of success. Marine life rebounds within marine reserves where hooks and nets are forbidden. Striped bass, severely depleted along our Atlantic shores, made a remarkable comeback when given a chance. Seabirds, kelp beds, and fish communities returned to the coastal waters off Los Angeles after waste discharges were reduced.

But such successes will remain the exception rather than the rule until we chart a new course for ocean management.

Our country must articulate a clear, strong commitment to our oceans. As mariners weathered storms for centuries with simple tools, our nation can navigate today's troubled seas. We know what we need: a compass, a chart, and the wind in our sails. That compass is a strong ocean ethic, the chart is a new legal framework, and the wind is our national will. The commitment of leaders and citizens alike is needed to steer us to healthy oceans.

Rising some 400 feet above the crashing surf of the Pacific Ocean, the Point Sur Lighthouse alerts ships to the dangers of the treacherous Big Sur coastline.

We take our oceans for granted. We must view our oceans as a public trust, and handle them in a way that ensures that living marine resources are there for our children and for future generations.

Leon E. Panetta
Chair of the Pew Oceans Commission
An excerpt from Mr. Panetta's testimony before the U.S. Commission on Ocean Policy, Washington, D.C. October 30, 2002

THE COMPASS: AN OCEAN ETHIC

In recent decades, our nation has made great strides in environmental and natural resource protection. We fought back at the sight of litter, fouled rivers, and sooty air. We discovered a national conscience and articulated an environmental ethic.

Our vast oceans—the final frontier on this planet—are now showing the same signs of stress that mobilized our nation 30 years ago. Pollution, poorly guided development, and habitat-destroying fishing practices are a sampling of humanity's heavy hand on the oceans. We are altering ecosystems and their capacity to support marine life, as well as their ability to provide the goods and services that we have grown to expect without thinking, just as we take for granted the beating of our hearts.

Extending strong environmental protec-

tion to the oceans is both a practical measure to preserve the ecological benefits that we require as a species and our moral obligation as the stewards of our planet.

It is time we apply this ethic to our oceans, our country's largest public resource.

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Sailboat off Newport, Rhode Island

THE CHART: DEFINING A NATIONAL OCEAN POLICY

A mariner turns to the charts in preparation for a voyage. Likewise, it is time for America to lay out a new policy that guides the nation toward healthy oceans.

Congress and the President should begin by enacting a National Ocean Policy Act, significantly adjusting our nation's attitude toward the sea and establishing the standards and expectations necessary to achieve healthy, productive, and resilient marine ecosystems. This action will facilitate a host of other changes including necessary adjustments in existing fisheries, pollution, and coastal management policies to protect ocean health.

Achieving the Commission's vision for our oceans requires action in the following critical areas: do no more harm to the oceans, protect pristine areas, and restore degraded marine ecosystems. To do no more harm, we must stop excessive fishing of already overfished stocks, end wasteful bycatch and unnecessary habitat damage from fishing gears and practices, reduce the polluted runoff from our city streets and farmlands, and curtail harmful development practices that degrade water quality and destroy coastal habitat.

We must place a premium on protecting and maintaining those areas that are relatively healthy and pristine, both on land and in the ocean. We should identify those areas critical to the functioning of productive coastal and marine ecosystems and place these areas off limits to harmful activities.

The United States should restore its degraded marine ecosystems actively and aggressively. These systems are tremendously valuable. Although most areas will never return to a pristine condition, we can at least restore the function and productivity of many of these systems.

THE WIND IN THE SAILS: LEADERS AND CITIZENS ALIKE

Even with a new sense of direction and a chart to guide us, we still need the power to make it happen. Charting a new course for the oceans will not be easy. It will take the time and dedication of countless individuals to work for—and demand—healthy oceans for our children and for ourselves.

A legacy of healthy oceans requires a national commitment from government, the private sector, and citizens alike. The commit-

ment must start with leadership from the President and Congress taking action on the necessary reforms to national laws and policies. Our governors should reinvigorate state efforts and expand the partnership with the federal government for coastal protection and management begun 30 years ago. Finally, we need a commitment from industry to reform its practices and from individuals to take responsibility for the impact of their choices on our oceans.

A NATIONAL COMMITMENT TO MARINE ECOSYSTEMS

We confront an ethical, environmental, and economic challenge that requires our nation to realign its posture toward the sea. Changing our policy course requires knowing where we want to go, applying the great energy required to overcome inertia, and taking action in time to avert disaster. Only a concerted and innovative effort will accomplish what the Commission's work alone cannot—compel action through leadership, not crisis.

This Commission has a vision of how the health of our oceans and coasts can be restored and protected. It is a vision based on the principle that we must treat our oceans as a public trust to be managed for the common good. It recognizes that the land and ocean are interrelated and that we must work regionally and locally to protect our ocean ecosystems and the watersheds that sustain them. The outcomes of this vision are healthy and plentiful marine life, thriving fishing communities, clean beaches and coastal waters, and healthful seafood.

We invite the American public to join with us to launch a national effort in behalf of future generations—to understand, restore, and protect the bountiful life and habitats in our vast ocean and coastal waters.

Orca, North Pacific Ocean

Part Three

DETAILED RECOMMENDATIONS

California garibaldi in a kelp forest, Santa Catalina Island, California

Chapter Ten
GOVERNANCE FOR SUSTAINABLE SEAS

1. DEVELOP A NEW NATIONAL OCEAN POLICY.

Enact a National Ocean Policy Act.

- Congress should enact a National Ocean Policy Act (NOPA) that, at a minimum,
  - addresses geographic and institutional fragmentation by providing a unifying set of principles and standards for governance;
  - establishes processes to improve coordination among governments, institutions, users of ocean resources, and the public;
  - provides adequate funding to accomplish these goals.

Through NOPA, reformulate national ocean policy to make healthy marine ecosystems the priority.

- Establish the main objective of the new national policy as the protection, maintenance, and restoration of the health of marine ecosystems.
- Require that marine resources be used in an ecologically sustainable manner.*
- Manage ocean activities consistent with the protection, maintenance, and restoration of marine biological diversity.
- In the case of uncertain or inadequate information, exercise precaution in favor of conservation.
- Use the best available scientific, social, and economic information to make decisions.
- Support research and education to improve basic understanding of marine ecosystems, and apply this information to ecosystem management.

Through NOPA, establish the following standards to guide ocean governance.

- Actions affecting United States' ocean waters or ocean resources must be conducted in a manner consistent with the protection and maintenance of healthy marine ecosystems† and the restoration of degraded marine ecosystems.
- Any action that may significantly affect United States' ocean waters or ocean resources will not be permitted unless and until it is demonstrated that the action, individually or in combination with other actions, will not significantly harm a marine ecosystem, nor impede its restoration.

Establish a strong implementation and compliance regime.

- Any federal agency proposing an action

*The Commission recommends defining "ecologically sustainable" to mean maintaining biological diversity, or ecosystem structure and functioning from one human generation to the next, so as not to deny future generations the goods and services provided by marine ecosystems that are enjoyed today (adapted from the Convention for the Conservation of Antarctic Living Marine Resources).

†"Healthy marine ecosystem" refers to the capability of an ecosystem to support and maintain a productive and resilient community of organisms that has a species composition, diversity, and functional organization comparable to the natural habitat of the region. Such an ecosystem is capable of providing a range of ecological goods and services to people and other species in amounts and at rates comparable to those that could be provided by a similar undisturbed ecosystem.

(including a license or permit) that is likely to significantly affect U.S. ocean waters or ocean resources must consult with the head of the National Oceans Agency. The agency head will determine whether the proposed action is likely to harm the health of a marine ecosystem. If so, the ocean agency head will recommend changes to the proposed action to bring it into compliance with the national standards.

- Each agency proposing an action is ultimately responsible for compliance with the national policy and standards.

2. IMPLEMENT REGIONAL OCEAN GOVERNANCE.

Establish regional ocean ecosystem councils.

- As part of the National Ocean Policy Act, Congress should establish regional ocean ecosystem councils that focus on the state/federal relationship at the regional scale and consist of appropriate federal, state, and tribal representatives.
- The major task of the regional councils is to develop and oversee the implementation of comprehensive regional ocean governance plans.
- The councils' geographic boundaries should be defined by statute and established initially to coincide with the jurisdictional boundaries of the regional fishery management councils established by the Magnuson-Stevens Act.
  - Boundaries may be adjusted within a few years, and as necessary thereafter, to incorporate new scientific information or sound management concerns.

The councils are charged with developing regional ocean governance plans.

- Enforceable regional ocean governance plans should be developed in compliance with NOPA to protect, maintain, and restore marine ecosystems. At a minimum, these plans should address
  - management of living marine resources;
  - protection of habitat;
  - protection of water quality;
  - management of development affecting marine ecosystem health.
- Regional plans are subject to the approval of the new federal oceans agency.

Regional councils should be representative and democratic.

- Federal, state, and tribal authorities with jurisdiction over ocean space and resources in a region constitute the executive decision-making core of regional ocean ecosystem councils.
- Participation by the broadest possible range of stakeholders—including local government officials, fishermen and other ocean resource users, and the general public—should occur through a robust and influential advisory process.
- Regional plans are required to be consistent with the national policy and standards of NOPA.

Regional ocean governance plans should be based on science.

- Councils should establish a science advisory committee to provide independent advice and, where appropriate, peer review.
- Regional ocean governance plans should assess the history and state of the marine ecosystems in the region, including influences from adjacent terrestrial ecosystems.
- Plans should identify key threats to marine ecosystem health in the region and gaps in knowledge and information.
- Plans should provide for the development and monitoring of criteria and indicators of the health of marine ecosystems in a region.
- Plans should establish clear and measurable management and restoration goals for marine ecosystem health.

Council plans should be clearly enforceable.

- NOPA requires federal agencies to comply with enforceable policies of an approved regional ocean governance plan.
- The consistency authority of the Coastal Zone Management Act should be expanded to include regional ocean governance plans. This will allow states to hold federal actions to consistency with regional ocean governance plans.
- States can appeal federal actions not in compliance with a regional plan to the National Oceans Agency and/or seek injunctive relief in federal court.
- Regional councils should assign clear roles and responsibilities among authorities.
- States are required to comply with enforceable policies of approved plans.
- The federal government can preempt state actions not in compliance with a regional plan.
- Third parties, through citizen suits under NOPA, can sue in federal court to compel compliance of any party (including the regional ocean ecosystem council as an entity) with a regional ocean governance plan.
- Default regional plans, developed by the lead federal oceans agency, should be imposed in the event that a regional ocean council fails to develop an approvable plan within a reasonable time.

Regional ocean ecosystem councils should coordinate with regional fishery management councils and other relevant entities.

- Regional ocean councils should review proposed state, federal, and regional government actions and advise the agencies proposing these activities on consistency with regional ocean governance plans.
- Regional ocean councils should coordinate among these authorities to ensure that ecosystem health is taken into account at all levels of government.
- Regional ocean councils should leave day-to-day management to the appropriate authorities. For example, federal fisheries management would remain the purview of the National Marine Fisheries Service and the appropriate regional fishery management council.

- The National Marine Fisheries Service and the fishery management councils must ensure that their actions are consistent with applicable regional ocean governance plan(s).
- The regional ocean ecosystem councils' role would be to consult with these entities regarding ecosystem concerns related to fisheries management, and to periodically assess overall progress toward achievement of the goals and policies of the regional ocean governance plans.
- Regional ocean governance plans need to be informed by the expertise and latest thinking of fishery management councils, metropolitan planning organizations, national estuary and watershed councils, and other local and regional authorities.

Strong incentives for participation should be provided.

- Substantial federal funding should be provided for the development and implementation (including enforcement) of regional ocean governance plans, the operation of regional ocean councils, and for ongoing monitoring and assessment.
- States should be required to provide some level of matching funds.
- Nonfinancial incentives for state and local government include
  - improved resource productivity through comprehensive, ecosystem-based management from 0 to 200 miles offshore;
  - harmonization of state and federal management of marine resources;
  - greater say-so in the management of marine resources throughout the Exclusive Economic Zone.

Regional ocean ecosystem councils should use zoning as part of their regional governance plans.

- Regional councils should utilize ocean zoning to improve marine conservation, actively plan ocean use, and reduce user conflicts.
- Regional ocean governance plans should consider a full range of zoning options. This includes marine protected areas, areas designated for fishing, oil and gas development, as well as other commercial and recreational activities.
- Ocean zoning should be implemented using a sequential building-block approach, starting with priority areas and essential components—such as marine reserves—first.
  - Initially, area-based management should begin with coordinating existing zones in the ocean, such as areas closed to fishing, shipping lanes, and areas for oil and gas extraction.
  - During this period, at a minimum, the legislative moratorium that prohibits oil and gas development in certain ocean areas should continue. Thereafter, any Congressional action to revise the moratorium should take into consideration the recommendations contained in the regional ocean governance and zoning plans, and should be consistent

with the national ocean policy of protection and maintenance of healthy ocean ecosystems.

- Over the next decade, ocean zoning should be applied more broadly on a regional basis to comprehensively plan and manage all activities in the oceans.

3. ESTABLISH A NATIONAL SYSTEM OF MARINE RESERVES.*

Congress should provide a mandate and authority for designating a national system of marine reserves.

- The regional ocean ecosystem councils should be empowered to designate areas of regional importance as marine reserves or networks of marine reserves. These reserves should reflect regional priorities and protect significant species and habitats.
- Congress should direct the national oceans agency, working in coordination with regional ocean ecosystem councils, to establish an inventory of potential reserves and nominate areas for Congress to consider including in the national reserve system.
- Congress should designate areas of special national significance as marine reserves.

Continue efforts to establish marine reserves under existing authority.

- Federal agencies should use their existing conservation and management planning and implementation authority to establish marine reserves or networks of marine reserves within designated marine protected areas (i.e., the National Marine Sanctuaries Program, National Parks, National Wildlife Refuges).

The new national oceans agency should manage the national system of marine reserves.

- The agency should be responsible for the development, implementation and management of reserves created under new authority in federal waters and for the coordination of federal agencies managing marine reserves under existing authority.
- The agency should work with the states and regional ecosystem councils to co-manage reserves that contain federal and state waters and coordinate with other federal agencies, such as the Department of the Interior, where federal land is adjacent to protected waters.

A national system of marine reserves should encompass significant portions of ecosystems and multiple habitats, including both benthic and pelagic components.

The establishment of marine reserves should not await action on a comprehensive ocean zoning program.

*A marine reserve is a type of marine protected area in which all extractive, additive, or ecologically destructive human activities are prohibited on a lasting basis, except as necessary for evaluation of reserve effectiveness and appropriate research. Destructive human activities include, but are not limited to, those that alter habitats, harm or kill organisms, or change the dynamics of the ecosystem.

4. ESTABLISH AN INDEPENDENT OCEANS AGENCY.

Congress should establish a National Oceanic and Atmospheric Agency as an independent agency outside the Department of Commerce.

- The agency's main objective is to oversee the implementation of NOPA on a national scale.
- This agency should consist, at a minimum, of
  - the current bureaus and programs of NOAA;*
  - the ocean minerals program of the Minerals Management Service (Department of the Interior);
  - the marine mammal and seabird jurisdiction and programs of the U.S. Fish and Wildlife Service (to place all ocean wildlife under the jurisdiction of the oceans agency);
  - the Chesapeake Bay Program and the National Estuaries Program at EPA;
  - coastal and marine components of EPA's Environmental Assessment and Monitoring Program (to create a unified coastal and marine monitoring capability);
  - aquaculture programs for marine species at USDA;
  - shoreline protection (beach renourishment and coastal erosion prevention) activities of the Army Corps of Engineers.

5. ESTABLISH A PERMANENT NATIONAL OCEANS COUNCIL.

Establish by statute a permanent national oceans council within the Executive Office of the President. Its objectives will be to

- provide well-structured interagency coordination on oceans issues and resolve interagency disputes on NOPA implementation;
- facilitate coordination among federal programs that have substantial effects on the ocean but are outside the national oceans agency. These include defense operations, programs affecting coastal water quality at USDA and the Department of Transportation, and the conduct of international ocean policy at the State Department;
- make recommendations to the President regarding resolution of interagency disputes that cannot be resolved by the council;
- ensure that all agencies are complying with the National Ocean Policy Act;
- coordinate and certify agency ocean budgets regarding national ocean policy.

Implement a Council structure that empowers the new national oceans agency to lead on ocean issues.

- Designate the head of the national oceans agency as chair of the new national oceans council.

*Since the U.S. Coast Guard has been transferred to the new Department of Homeland Security, the Commission decided not to recommend that it be included in the new national oceans agency. However, the Coast Guard's environmental enforcement and oil and hazardous materials spills responsibilities are important safeguards for the nation's marine resources, and it will be vital that the Coast Guard continue to uphold these missions within the new department. The Coast Guard's presence on the water will likely increase because of national security concerns, which may result in greater opportunities for fisheries and environmental monitoring and enforcement.

- Specify council membership by law to include
  - Secretary of the Interior;
  - Administrator of the EPA;
  - Secretary of State;
  - Secretary of Defense;
  - Secretary of Agriculture;
  - Secretary of Transportation;
  - Secretary of Homeland Security;
  - Director of the Office of Management and Budget;
  - Director of the National Science Foundation;
  - Other department and agency heads who from time to time are directed by the President to attend.
- Establish a position of national oceans adviser to the President within the Executive Office of the President. The position should be required by law and the national oceans adviser should
  - be named executive director of the national oceans council;
  - have a small staff to service the council;
  - advise the President on ocean issues in general, matters related to the National Ocean Policy Act, and actions of the council.
- Establish a Deputies Committee at the assistant secretary level for day-to-day implementation of policy, to prepare issues for the council, and to oversee implementation of council and presidential decisions. The national oceans adviser should chair the Deputies Committee.

Joel W. Rogers

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Chapter Eleven
RESTORING AMERICA'S FISHERIES

Lobster buoys in York, Maine
Deb Antonini/Pew Oceans Commission

Congress should amend the Magnuson-Stevens Act and other applicable fisheries laws to codify the following recommendations as national marine fishery policy.

1. REDEFINE THE PRINCIPAL OBJECTIVE OF AMERICAN MARINE FISHERY POLICY TO PROTECT MARINE ECOSYSTEMS.

- The principal objective of American fishery policy should be to protect the long-term health and viability of fisheries by protecting, maintaining, and restoring the health, integrity, productive capacity, and resilience of the marine ecosystems upon which they depend. This objective should apply to all U.S. ocean waters.
- The socioeconomic objective of American marine fishery policy should be to conserve and manage fisheries in order to support diversity, flexibility, resilience, and adaptability within the industry and fishing communities.

Establish an explicit statutory priority between these objectives.

- In cases of conflict between objectives or in cases where information is uncertain or inconclusive, the principal ecological objective should always take precedence over the socioeconomic objective, for the simple reason that achieving social and economic objectives depends upon healthy ecosystems.

Develop specific, measurable criteria and indicators for the health and integrity of marine ecosystems.

- Conduct a Committee of Scientists process similar to that followed under the National Forest Management Act.

2. SEPARATE CONSERVATION AND ALLOCATION DECISIONS.

Create a clear separation between conservation and allocation decisions in the fishery-management planning process.

- Core conservation decisions should be made by the NMFS, or a revamped fishery service within a new independent oceans agency. These decisions should originate at the regional offices with oversight by the national headquarters office. At a minimum, these decisions include setting
  - ecologically safe levels of exploitation (total catch and bycatch limits);
  - specific habitat and area protections;
  - specific protected species requirements (threatened and endangered marine mammals, sea turtles, seabirds, and fish).
- Conservation decisions should be based upon recommendations from regional science and technical teams—composed of federal, state, and academic scientists.
  - Regional science groups should recommend ecologically safe catch limits and other conservation criteria for a fishery management plan, informed by—and

consistent with—goals, indicators, and targets of a regional ecosystem plan.
  - The work of the regional science groups should be regularly subject to independent peer review.
- The regional fishery councils should make allocation decisions.
  - Allow individual fisheries to develop their own allocation plans pursuant to approval and coordination of plans by the regional fishery councils.
  - Allow regional councils to improve upon or set higher conservation standards than those established in federal law or by NMFS, but ensure that established conservation standards are not undercut in the allocation process.
  - NMFS should retain authority to review a council's allocation decisions for consistency with conservation.
  - NMFS should retain responsibility for implementation after the conservation and allocation planning processes are completed.

Create a mechanism that regularly provides independent scientific oversight.

- Establish a Marine Fisheries Oversight Commission along the lines of the Marine Mammal Commission, or require periodic scientific audits by the National Academy of Sciences, or both.*

Allow citizen suits.

- Include a citizen suit provision in fishery conservation and management laws like those in most other major federal environmental statutes. Citizens must be allowed to hold fishery managers who violate the law accountable, or to force reluctant or negligent fishery management agencies to enforce the law.†

3. IMPLEMENT ECOSYSTEM-BASED PLANNING AND ZONING.

Implement affirmative planning and management.

- Prohibit fishing without an approved plan.
- Require management of core problems such as bycatch, habitat damage, and overcapacity as a condition of fishing.
- Require a cooperative data-collection and planning program for existing fisheries where information is inadequate to determine whether overexploitation is occurring. Such programs should be modeled on an emerging fisheries policy.
- Enact an emerging fisheries policy.††
  - The purpose of the policy should be to allow industry development of new fish-

*An independent commission would likely exert more effective and consistent oversight by staying involved in ongoing planning, participating in decision-making processes as events occur rather than after the fact, and building institutional memory.

†The Commission has no desire to see the federal courts manage marine fisheries, but allowing citizens to seek redress through the courts is part of our constitutional system of checks and balances and a central element of good government.

††Concepts from Alaska's Emerging Fishery Policy informed the development of this recommendation.

eries in a manner that promotes sound scientific management and long-term conservation of the resources being developed and the relevant ecosystem.

- Potential development of new fisheries should be allowed through exploratory fishing permits. To obtain such a permit, applicants should work with the relevant fishery management authority to develop a research and management plan detailing how the necessary stock assessment and other research on and management of the stocks proposed for the new fishery will be funded and conducted.
- Matching grants should be available for the industry to assist with management and administrative costs.
- If approved, the new fishery should only be allowed to expand if accumulated knowledge shows the fishery can grow in an ecologically sustainable manner.

Implement ecosystem-based fishery management.

- Make marine ecosystems the organizing principle for fishery management.
- Require that fishery management plans are developed based upon consideration of how the entire ecosystem that supports the fishery will be affected by fishing.
- Redefine overfishing in an ecosystem context to consider the level of fishing that has detrimental effects in the ecosystem, even though it may not harm a particular target species.

Apply zoning in fishery management plans.

- Incorporate comprehensive zoning within fishery management plans to proactively partition planned areas into sections designated for specific uses.
  - Areas not designated for particular uses should be closed to those uses.
  - Managers should evaluate the life history and habitat requirements of species to determine the appropriate types of area management tools to employ, including spatial and temporal closures, spawning closures, habitat protection areas, bycatch reduction areas, and marine reserves.
  - Closed areas should be a required element for any fishery management plan in which there is substantial uncertainty or lack of information about the status of heavily exploited major fishery stocks.

4. REGULATE USE OF FISHING GEAR THAT IS DESTRUCTIVE TO MARINE HABITATS.

Create a fishing-gear zoning program designed to protect seafloor habitats from the adverse impacts of fishing practices. The program should have an immediate and a transition phase. Regulations should be developed immediately to

- prohibit the use of mobile bottom fishing gear in habitat areas known to be especially sensitive to disturbance from such gear, including but not limited to coral-reef and deepwater coral habitats, complex rocky bottoms, seamounts, kelp forests, seagrass beds, and sponge habitats;
- prevent expansion of mobile bottom gear into geographical areas where it is not

presently employed;

- prevent expansion of the numbers of vessels employing mobile bottom gear by
  - restricting the numbers of licenses, permits, or endorsements to no more than current fleet sizes;
  - allowing transfers of licenses only to gears that are documented to have lower impacts on habitats;
  - allowing reentry of latent mobile gear effort only with gears documented to have lower impacts on habitats.

Over a five-year transition period, implement a zoning regime that (a) limits bottom trawling and dredging to only those areas where best available science indicates that such gear can be used without altering or destroying important or significant amounts of habitat; and (b) closes all other areas to these fishing practices.

- Convene an independent panel to develop rigorous scientific criteria and implement a science-based process for designating zones open to mobile bottom gear fishing.
- Implement a gear-substitution program to reduce the use of mobile bottom gear by
  - conducting a viability assessment to determine fisheries dependent on such gear;
  - providing funding to replace gear in fisheries that cannot be viably conducted without mobile bottom gear.
- Fund a gear-modification research program to redesign mobile bottom gear to reduce habitat damage in fisheries that cannot be viably fished without such gear.
- Close areas to mobile bottom gear fishing if NMFS fails to implement the zoning regime by the end of five years, unless and until it has been determined that the best available science indicates such gear can be used without altering or destroying important or significant amounts of habitat or reducing biodiversity.

5. REQUIRE BYCATCH MONITORING AND MANAGEMENT PLANS AS A CONDITION OF FISHING.*

- The statutory goal of these plans should be to reduce bycatch to levels approaching zero.
- The statutory definition of bycatch should be broadened to include incidental mortality of all nontarget species (fish and other living marine resources), and mortality by lost or abandoned gear.

*The Commission's investigation identified the following principles to guide bycatch management:
– timely collection, compilation, and analysis of data are fundamental to conservation and management; onboard observer programs are the most effective bycatch monitoring scheme and should be used wherever practicable;
– successful bycatch management must be tailored to the specific set of circumstances for each fishery, gear type, ecosystem, and species;
– effective bycatch monitoring and reduction programs usually depend on a complementary combination of technology and management measures;
– involving fishermen in the bycatch decision-making process is critical for buy-in with outcomes and innovation;
– scientifically established bycatch limits are necessary for conservation and to encourage innovation by fishermen;
– a specific trigger, rather than just a broad mandate to monitor and minimize bycatch, is required to bring the necessary parties to the negotiating table and compel them to develop bycatch plans.

- Bycatch plans should include, at a minimum,
  - an observer program or other appropriate, effective monitoring scheme;
  - total fishing mortality limits that include bycatch;
  - a requirement that bycatch mortality be factored into stock assessments.
- The National Marine Fisheries Service should establish by regulation national criteria that determine what constitutes an adequate and appropriate bycatch monitoring and minimization plan under different circumstances (e.g., minimum observer coverage levels). Only plans that meet these criteria and applicable federal laws should be approved.
- Each fishery should be allowed to develop its own plan. A tightly constructed stakeholder process modeled on the Marine Mammal Protection Act Take Reduction Teams should be the principal mechanism to develop these plans. The lobster zone councils used in the Maine lobster fishery provide another potential model.
- Individual bycatch quotas for valuable fish species (except threatened and endangered species) could be used to manage bycatch. Conservative catch quotas should be set for species, accounting for intended and unintended catch. Fishermen should be allowed to keep fish they catch within conservative limits, rather than being forced to discard and waste one species because they are in a target fishery for another.

6. REQUIRE COMPREHENSIVE ACCESS AND ALLOCATION PLANNING AS A CONDITION OF FISHING.*

Establish a mandatory national policy to guide development of fishery allocation plans. Each allocation plan should, at a minimum,

- limit access and entry to all fisheries to help shape and match the size of fishing fleets and their catching capacity to the health of exploited populations and the integrity, productive capacity, and resilience of marine ecosystems;
- implement precautionary total allowable catches (TAC), or alternative fishing privileges that demonstrably control exploitation within ecologically safe limits;
- allocate privileges in ways that properly align incentives, allow for the orderly operation of a fishery (e.g., individual or community fishing quota programs), and maintain flexibility, resilience, and adaptability within the industry and fishing communities;
- reduce fishing capacity where necessary, using transitional buyback programs and providing other transition assistance for displaced fishermen and affected fishing communities;
- recover an appropriate share of the continuing costs of fisheries management, enforcement, and research as well as additional funds to mitigate potential adverse effects of fishery allocation plans on individuals and communities;
- be subject to a double referendum where a

*Several aspects of this recommendation are modeled on the California Restricted Access policy.

super majority of the permit/license holders in a fishery approves the initial development as well as implementation of the plan;

- be reviewed at least every five years. If appropriate, the plan should be revised to ensure it continues to meet the objectives of this policy, the public interest, other relevant laws and regulations, and fishery participants.

If a fishery or regional fishery management council fails to revise or update an implementation and allocation plan when required, a default plan should be imposed by the federal fishery agency.

Limit access and entry to all fisheries.

- Subject all participants in U.S. fisheries to permitting or licensing, both a general fishing permit/license as well as fishery-specific permits/licenses.
  - Require that limited access/entry programs be designed to keep the level of catching capacity and fishing power in any fishery slightly under the level that is ecologically sustainable. For some severely depleted fisheries, it will be necessary to develop a plan to reduce capacity initially and to provide a mechanism that allows appropriate increases in catching capacity as the stock rebuilds.
  - Each plan should set a catch capacity and fishing power goal appropriate for the fishery and require mechanisms and schedules for achieving that goal if the fishery has excess capacity. Capacity goals should be based upon appropriate ecological, social, and economic analyses of the relevant fishery and ecosystem. The goal should be stated as a clear, measurable, and objective factor, or set of factors, that fairly represent the catching capacity or fishing power of the fleet.
  - Each fishery should design a mandatory apprenticeship program to create a mechanism for new entrants to the fishery. These programs should foster improved stewardship through training in conservation and responsible fishing practices. Only those prospective new entrants who complete the program can receive a license.

Apply fishing privileges, such as precautionary total allowable catches (TACs), known to effectively control exploitation within ecologically safe limits.

- Implement a three-year monitoring program for any fisheries that use indirect approaches* to limit catches in order to determine if the fishery can keep catches below the target TAC.
- Impose default TACs if the monitoring program shows that catches are exceeding the biologically safe limits.

*By definition, indirect approaches to limit exploitation of fish populations, such as reducing the number of allowed fishing days, do not directly control the amount of catch. The Commission's investigation identified that indirect approaches are unreliable and inefficient.

Allocate fishing privileges to align incentives, allow for the orderly operation of a fishery, and maintain flexibility, resilience, and adaptability within the industry and fishing communities.

- Individual or community fishing quotas (IQs or CQs), if properly monitored and enforced, appear to be among the more effective allocation mechanisms.
- For instances where IQs or CQs are chosen to allocate direct catch limits, they should be implemented according to the following three national standards:

1. Periodically allocate quota using a combination of catch history records, bids in the form of offered royalty payments on the catch, and conservation commitments offered by the bidder.

- Partition quota into different categories for different types of fishing operations before being auctioned—some for large vessels and corporations, some for owner operators and smaller vessels, some for new entrants, etc. Quota should also not be transferable among these different categories.
- Place royalty payments in a secure fund to be used initially for buybacks and community economic development and then for cost recovery. Funds beyond cost recovery should go toward improved fishery research, management, and enforcement.

2. Regularly review and evaluate quota programs to

- maintain flexibility in anticipation of changes within the industry and fishing communities resulting from the transition to adaptive, ecosystem-based management;
- assess the performance of the program to ensure it continues to meet the objectives of the national policy;
- revise the program if it fails to meet clear conservation performance standards, timetables, and other evaluation criteria.

3. Prevent excessive consolidation and concentration of economic power by establishing an excessive shares cap to limit the amount of quota any one person or corporation can own.

Reduce fishing capacity, where necessary, with transitional buyback programs and provide other transition assistance for displaced fishermen and affected fishing communities. Such programs should

- retire capacity permanently rather than allowing it to shift to other fisheries;
- restrict activation of latent fishing capacity in the buyback fishery;
- reduce the incentives and subsidies that could encourage remaining fishery participants to increase their fish-catching capacity.

7. ESTABLISH A PERMANENT FISHERY CONSERVATION AND MANAGEMENT TRUST FUND.

- The fund should be available without appropriation or fiscal year limitation.
- It should be used only for the purposes of improving fishery research, data collection,

management, enforcement, and habitat restoration. In the first 5 to 10 years of operation, it should also be available for transitional buyback and community development programs.

- Revenues should be applied within the region where they were collected.
- Within regions, the fund should be shared fairly among the federal government and state programs for coastal fishery management.
- The Secretary of Commerce should appoint regional advisory panels with equal representation from members of the industry, scientific community, conservation community, and appropriate local governments to ensure that revenues are apportioned fairly and wisely.
- The fund should not be used to defray the general costs of government or to absolve the federal government of responsibility to fund fishery and ecological research and science.
- Potential revenue sources for the fund include, but should not be limited to
  - revenues generated by royalty payments on landed catch (calculated as a percentage of the value of the landed fish);
  - fees collected from fines and other penalties.

Jeff Rotman/www.jeffrotman.com

Plaice and flounder in a trawl net off Cape Cod, Massachusetts

Chapter Twelve
PRESERVING OUR COASTS

Development near Charleston, South Carolina
Dana Beach, South Carolina Conservation League

1. ADDRESS NONPOINT SOURCE POLLUTION AND PROTECT WATER QUALITY ON A WATERSHED BASIS.*

Establish water quality standards for nutrients in rivers, lakes, estuaries, and coastal waters.

- Water quality standards under the Clean Water Act are a legally enforceable benchmark against which progress toward addressing nonpoint and other sources of pollution can be measured.
- While standards for many toxic pollutants exist, few areas have standards for nutrients. Given the pervasiveness of the nutrient pollution problem, additional resources should be devoted to accelerate development of nutrient standards for major aquatic habitats.

Take additional steps to control major uncontrolled or undercontrolled sources of nutrient pollution.†

- EPA should ensure that states are controlling major underregulated point sources of pollution—such as concentrated animal feeding operations and stormwater.
- Congress should amend the Clean Water Act to require states to control nonpoint sources of pollution.
- Eligibility for federal agricultural subsidies should be conditioned on the implementation of best management practices for controlling polluted runoff from farms and fields.

Require watershed-based water quality compliance planning.

- The Clean Water Act requires that states determine the total maximum daily load (TMDL) of pollutants that a water body can absorb and still satisfy water quality standards, including meeting designated uses. EPA should require timely development of TMDLs, identifying point and nonpoint sources of pollution and the specific pollution reductions from point and nonpoint sources necessary to comply with the law.
- For coastal watersheds, plans already developed under the Coastal Nonpoint Pollution Control Program of the Coastal Zone Management Act provide the core of an enforceable watershed protection strategy.
- EPA should use existing authorities to reinvigorate the "continuing planning process" required by the Clean Water Act, making it a process through which the states achieve the point and nonpoint source pollution reductions indicated by TMDLs. States should use TMDLs as a blueprint for action to address water quality problems at the watershed level.

Provide a complementary suite of incentives for improving water quality and disincentives for activities that harm water quality.

- Congress should give the states flexibility to use negative interest loans and grants from

*Some of these recommendations overlap with recommendations on point and nonpoint source pollution. They are presented here to illustrate the Commission's suggestion for a comprehensive, watershed-based approach to controlling all forms of water pollution.

†For details, see recommendations 1 and 2 in Chapter 13.

the State Revolving Fund established by the Clean Water Act to address nonpoint sources of pollution.

- Funding for the control of nonpoint source pollution under the Clean Water Act should be tied to progress in reducing nonpoint source pollution, and specifically to implementation of TMDLs, where these are in place.
- Funding and incentives provided through the farm conservation programs administered by USDA and federal transportation legislation to address nonpoint source pollution associated with agriculture and transportation infrastructure should be coordinated with watershed-protection strategies.
- Federal subsidies for agriculture, transportation, and other kinds of development that contribute to nonpoint source pollution should be tied to progress toward compliance with the Clean Water Act, specifically to progress in reducing nonpoint source pollution and attaining water quality standards.

2. IDENTIFY AND PROTECT FROM DEVELOPMENT HABITAT CRITICAL FOR THE FUNCTIONING OF COASTAL ECOSYSTEMS.

Congress should provide a significant, dedicated, and permanent source of funding for habitat protection.

- Congress should consider revenue derived from outer continental shelf oil, gas, and mineral development for this purpose.
- Funding should be allocated to the states and territories in a way that does not provide an incentive for offshore oil and gas development; recognizes that the impacts of offshore oil and gas development, and the onshore infrastructure required to support it, are greatest in the coastal zone; ensures that grants to states and communities are used for environmentally beneficial purposes.

Congress should make comprehensive habitat-protection planning by the states a condition for receipt of any new, dedicated federal conservation funds.

- While the bulk of funding should go to actual habitat protection, a reasonable portion of the funding should be set aside for habitat-protection planning.
- In addition to fee title acquisition, habitat-protection programs should purchase, or solicit the donation of, development rights and conservation easements to maximize conservation benefits.
- Public and private entities involved in habitat and watershed protection should strengthen and expand existing partnerships, and seek out new partnerships, to protect coastal ecosystems.

Congress should expand the scope of the Coastal Zone Management Act to include a mandate for coastal habitat protection through property acquisition, cooperative management, and technical assistance.

- Congress should amend the Coastal Zone Management Act to create a coastal habitat protection fund administered by the National Estuarine Research Reserve System.
- To meet its new responsibilities, the

National Estuarine Research Reserve System should be given a strong, unambiguous stewardship mission.

- Congress should direct the National Estuarine Research Reserve System to develop innovative partnerships for watershed protection among all levels of government and the private sector.

3. INSTITUTE EFFECTIVE MECHANISMS AT ALL LEVELS OF GOVERNMENT TO MANAGE DEVELOPMENT AND MINIMIZE ITS IMPACT ON COASTAL ECOSYSTEMS AND THEIR WATERSHEDS.

Municipalities and counties should change their zoning and subdivision codes to promote compact growth near urban centers, to discourage growth outside town centers in rural areas, and to reduce impervious surface cover wherever possible.

States should take a more active role in managing growth.

- Protect environmentally sensitive lands, as discussed under coastal development recommendation number 2.
- Require local growth-management planning as a condition for receipt of state and pass-through federal development assistance, and ensure that state and local growth and transportation planning comport with statewide habitat protection plans.
- Coordinate policies and practices among local jurisdictions and, to the extent possible, with adjacent states to ensure a rational regional approach to growth management.

Congress and the executive branch should ensure that federal activities support, not undermine, state and local efforts to manage growth.

- Federal transportation and development funding should be available only to states that are complying with federal environmental laws. (See details under coastal development recommendation number 4 below.)
- Federal grants and loans should be required to be used consistent with state and local growth management efforts.
- Tax structures should be examined at all levels of government to ensure that they are supporting compact, appropriately sited growth.

4. REDIRECT GOVERNMENT PROGRAMS AND SUBSIDIES AWAY FROM HARMFUL COASTAL DEVELOPMENT AND TOWARD BENEFICIAL ACTIVITIES, INCLUDING RESTORATION.

Congress should enact substantial reforms of the Army Corps of Engineers, including

- legislation ensuring that Army Corps of Engineers projects are environmentally and economically sound, and reflect national priorities articulated in the new National Ocean Policy Act;
- uniform standards for Army Corps participation in shoreline restoration projects, which ensure that
  - the full range of alternatives to intervention in coastal geological processes is considered,
  - costs and benefits are considered broadly and over a minimum 50 year time horizon, and

- mitigation is carried out in those cases where intervention is justified.

- transformation of the Corps—over the long term—into a strong and reliable force for environmental restoration, to work in partnership with natural resource management agencies. (Mechanisms for this change include authorization and appropriations bills.)

Congress should reform the National Flood Insurance Program.

- Set premiums that reflect the true risk of coastal hazards.
  - Additional funds could be used to enhance the buyout program, further reducing exposure of the program.
- Phase out coverage of repetitive loss properties.
  - Congress should provide more funding for buyout programs.
  - Legislative changes should terminate coverage for most properties after a certain number of claims.
- Deny coverage for new development in hazardous or environmentally sensitive areas.*

Congress should direct the Army Corps of Engineers, FEMA, and other appropriate agencies to develop a comprehensive floodplain management policy that emphasizes nonstructural control measures.

- Appropriate measures would include buyouts, zoning changes, and the purchase of flood easements in concert with engineering measures to restore natural floodplain functioning.

Congress should condition eligibility for federal transportation, development, and agriculture aid on compliance with environmental laws.

- Federal transportation and agriculture subsidies should be contingent on EPA certification of sufficient progress toward compliance with the Clean Water Act, and specifically with development and implementation of TMDLs, where these are needed to achieve water quality standards and designated uses.
- For areas where transportation infrastructure and the land-use patterns resulting from it are substantially contributing to water quality impairment, Congress should
  - require that state transportation plans assess and address the effect of transportation projects (and induced development) on water quality;
  - set aside a portion of federal funds for these purposes.

*The Commission recognizes that on many islands there may be no developable land that is not within the floodplain. It does not advocate denying flood insurance solely based on location in the floodplain in these cases, but building codes and the siting of new development should take into account relative risk (such as elevation above sea level) in all cases.

Chapter Thirteen
CLEANING COASTAL WATERS

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These recommendations will be most effective if implemented as part of a comprehensive, watershed-based approach to controlling water pollution. The Commission's recommended strategy for watershed-based water quality protection is described in detail in the coastal development sections of this report.

1. REVISE, STRENGTHEN, AND REDIRECT POLLUTION LAWS TO FOCUS ON NONPOINT SOURCE POLLUTION ON A WATERSHED BASIS.

All states should establish ambient water quality standards for nitrogen, and on a watershed-by-watershed basis identify additional nutrients and toxic pollutants for which water quality standards are needed to protect the health of marine ecosystems.

- Numerical standards should be established where possible, but narrative standards may be needed for nutrients so that ecosystem effects of eutrophication are identified and addressed.*

Congress should amend the Clean Water Act (CWA) to require the use of best management practices for agriculture and development to control polluted runoff.

- The EPA—in consultation with the U.S. Department of Agriculture, U.S. Department of Transportation, and other appropriate agencies—should establish baseline standards for best management practices (BMPs) to control runoff, as it has done with technologies and practices to control point source pollution.
- The EPA, USDA, U.S. DOT, and other appropriate agencies should jointly identify and publicize regionally appropriate nonpoint source BMPs, develop a program for certifying their implementation, and monitor their effectiveness in reducing pollution.†

Compliance with the CWA should be a condition for receipt of federal funding for activities—such as agriculture and transportation—that contribute substantially to polluted runoff.

- The implementation of BMPs to control polluted runoff should be a condition for receipt of federal agricultural subsidies for farms and animal feeding operations above specified sizes.
- Progress toward compliance with the CWA should be a condition for state eligibility for federal transportation funds. (The linkage between transportation, transportation funding, land use and nonpoint source pollution is described in detail in the coastal development sections of this report.)

*Under the Clean Water Act, EPA first develops water quality criteria for pollutants, and then the states implement water quality standards consistent with these criteria. EPA has set 2004 as the date certain for the development of nutrient criteria for freshwater; guidelines for the development of criteria have been completed for estuaries, while guidelines for coastal and wetlands criteria have yet to be completed.

†Examples of well-established BMPs include planting winter cover crops; returning marginal farmland to wetlands and expanded floodplains; removing land vulnerable to high rates of erosion and nitrogen loss from production; constructing wetlands and vegetative buffers to intercept the drainage from farm fields; and reducing the application of nitrogen-based fertilizer to lawns and golf courses.

Congress and the executive branch should develop and deliver a broad package of incentives to reduce nonpoint source pollution.

- Congress should establish a "yield guarantee" program under which farmers who verifiably reduce their use of nitrogen-based fertilizer are compensated to cover any associated loss of crop yield. In some watersheds, the agronomic rates determined by Agricultural Extension services at Land Grant universities will be sufficient; in other watersheds, the amount of nitrogen-based fertilizer may need to be lower than the agronomic rate to ensure sufficient reduction in nitrogen runoff.
- Building upon changes already made in the federal Farm Bill, Congress and USDA should increasingly focus agricultural conservation programs to more effectively address polluted runoff and nutrient pollution.
- Substantial funding should be made available under the Farm Bill, Clean Water Act, and other sources for outreach, education, training, and technical assistance to farmers and the operators of animal feeding operations regarding the causes and effects of polluted runoff, and the implementation of BMPs to reduce it.

Control of nitrogen oxides, mercury, and other pollutants under the Clean Air Act should mitigate the effects of atmospheric deposition of these pollutants on marine ecosystems.

2. ADDRESS UNABATED POINT SOURCES OF POLLUTION.

Concentrated animal feeding operations should be brought into compliance with existing provisions in the CWA.

- Animal feeding operations with more than 1,000 "animal units"* (CAFOs) and smaller operations that are adversely affecting water quality† should be required to obtain a National Pollutant Discharge Elimination System (NPDES) permit.††
- EPA should establish baseline terms and conditions for NPDES permits for CAFOs to substantially reduce water pollution from such operations. Permit requirements for CAFOs should include, at a minimum,
  - a requirement for a nutrient management plan covering the animal feeding facility, waste-holding facilities, and the ultimate disposition of the waste generated by the facility;
  - a process for phasing out the use of open air and unlined lagoons for waste storage;
  - restrictions on spray application of animal manures to reduce ammonia emissions.

Funding should be made available for development of biological nutrient removal technology standards to reduce nitrogen loads from publicly owned treatment works

*EPA defines "animal unit" as a unit of measurement for any animal feeding operation calculated by adding up the various numbers of different species of animals present at one facility. For example, 1,000 cattle = 2,500 pigs = 55,000 turkeys.

†According to EPA, all animal feeding operations will develop, and be responsible for, implementing a technically sound, economically feasible, site-specific comprehensive nutrient management plan by 2009.

††Point sources must possess a NPDES permit to discharge wastewater under the CWA.

and for municipalities to install biological nutrient removal treatment in watersheds where such loads are a significant source of water quality impairment.

Congress should amend the Clean Water Act to regulate cruise ships as point sources of pollution in state and federal waters.

- Black, gray, bilge and ballast-water discharges from vessels above a certain capacity (large passenger vessels) should be regulated as point sources of pollution under the CWA.
- EPA should develop effluent standards for discharges from vessels, and large passenger vessels should not be allowed to discharge within the Exclusive Economic Zone black water and gray water that do not meet the effluent standards.
- Large passenger vessels should be required to monitor and report their own discharges and the U.S. Coast Guard should periodically check onboard waste-treatment equipment and discharges to ensure compliance with effluent guidelines.
- Potentially hazardous waste and treatment byproducts should be disposed of in appropriately permitted onshore facilities.
- States should either be given or retain the necessary authority to
  - inspect cruise ships in their waters;
  - petition EPA to establish no-discharge zones in their waters;
  - charge a passenger fee to cover enforcement costs, as they deem appropriate.

Congress should enact legislation to require ballast-water treatment for all vessels carrying ballast water in U.S. waters, and to regulate ballast-water discharge through a permitting system administered jointly by the U.S. Coast Guard and EPA.

- The legislation should direct EPA, in cooperation with the U.S. Coast Guard, to develop a permit program under the CWA for ballast-water discharges.
- At a minimum, this program should include
  - the development of standards for ballast-water treatment;
  - uniform methods for verification and enforcement;
  - development of effluent guidelines for ballast-water discharges in U.S. waters.
- A program developed as part of the existing NPDES program is the preferred approach, allowing for appropriate division of responsibility between the U.S. Coast Guard and EPA.
- Alternative arrangements for treatment and discharge should be made for vessels traveling only between domestic ports and staying within the EEZ. Coastwise-operating vessels should not be exempt from requirements for ballast-water management based on their itinerary and shipping route.
- Congress should authorize the appropriate agencies to levy fees on dischargers and fines for illegal discharges to pay for administration of the program.

The United States should support finalization and ratification of an international convention on ballast-water management (currently being developed by the International Maritime Organization).

- The United States should encourage the development and adoption of a ballast

water convention consistent with the domestic program outlined above.

3. CREATE A FLEXIBLE FRAMEWORK TO ADDRESS EMERGING AND NONTRADITIONAL SOURCES OF POLLUTION.

Invasive Species

A national electronic permitting system should be created under the National Invasive Species Act to facilitate communication and track imports of live species that may result in aquatic introductions.

- As many vectors as possible, including live food, bait, aquaria species, pets, research specimens and other commodities, should be identified and monitored, and where possible, eliminated. A watch list should be developed and maintained for known invasive species, with a process for additions of new species found to be harmful. The system should include an application requirement for any vendor interested in importing live marine species.

An inventory of existing species and their historical abundance should be developed for each regional marine ecosystem.

- These inventories should be keyed to the ecosystem characterizations being developed under the National Ocean Policy Act (NOPA) to provide a baseline for recognizing and appropriately managing invasive species.

Congress should provide adequate funding to develop statewide invasive species management plans that include provisions for inventorying, monitoring, and rapid response.

- These plans should include both short-term rapid response and long-term management components. Currently, states are funded to implement the plans, but have no resources to develop them. These plans should be consistent with NOPA and the regional ecosystem plans.

Sound

A comprehensive research and monitoring program should be established to determine the effects of sound sources on living marine resources and ecosystems.

- A nationally coordinated, strategic research agenda should be developed with priority given to studies that assess the effects of sound on endangered or threatened species.
- Sound should be among environmental factors considered for inclusion in monitoring plans developed for the regional ocean governance plans. Where sound is considered likely to have a significant effect on the health of marine ecosystems, criteria and indicators for sound levels, and management measures for sound should be included in regional ocean governance plans.
- Priority areas should be identified for long-term monitoring.

Activities that generate significant amounts of potentially harmful sound should be regulated consistent with the requirements of federal law, including the Marine Mammal Protection Act, the Endangered Species Act, the National Environmental Policy Act, the Magnuson-Stevens Act, and the Coastal Zone Management Act.

Consideration should be given to requiring the utilization of best available control technologies, where the generation of sound has potential adverse effects.

- Such technologies include ship design, alternatives to seismic exploration, and computer simulations.

The environmental ramifications of any sound-producing project should be taken into formal consideration at the planning stages of the project, before significant resources, time, and money have been devoted to its development.

4. STRENGTHEN CONTROL OVER TOXIC POLLUTION.

Congress should ratify the Stockholm Convention on Persistent Organic Pollutants (POPs), which calls for a phaseout of production of 12 of the most dangerous toxic substances.

- The implementing legislation should include a process for allowing the addition of chemicals to the existing list of 12, if reliable data reveal they are sufficiently toxic.

EPA should develop and lead a comprehensive monitoring program to quantify levels of particular toxic substances in designated ocean habitats and species.

- EPA should complete its Ocean Dumping Site inventory, which will allow regulatory authorities to identify key sources of toxic contamination underwater and in sediments.
- Mercury, PCBs, PAHs, and other contaminants should be monitored in marine species at sites of particular concern, such as the 100 ocean dump sites, active offshore oil rigs, and industrial sites.
- This monitoring program should be coordinated with Food and Drug Administration and EPA seafood contaminant advisory efforts, to enable people to know where their seafood comes from and what it contains.

Sufficient resources should be devoted to studying the effects of toxic substances in the marine environment.

- Needed research includes (a) studies on mercury in fish and other species that are located near offshore oil rigs and in other areas where species may be affected by drilling muds and contaminated sediments; (b) the effects of PCBs and other toxic substances on marine mammals—particularly in the polar regions; and (c) the effects of chronic exposure to PAHs on marine species and ecosystems.

Chapter Fourteen
GUIDING SUSTAINABLE MARINE AQUACULTURE

Farm-raised oysters, Eliot, Maine
Laura Stadig, Spinney Creek Shellfish, Inc.

1. IMPLEMENT A NEW NATIONAL MARINE AQUACULTURE POLICY BASED ON SOUND CONSERVATION PRINCIPLES AND STANDARDS.

Adopt national and regional aquaculture standards to limit negative impacts of aquaculture activities on marine ecosystems.

- The national oceans agency should establish national marine aquaculture standards, defining minimum requirements for aquaculture facility performance, to ensure marine aquaculture practices are ecologically sustainable. These standards should
  - minimize adverse effects on living marine resources, physical habitat, and marine ecosystems;
  - consider siting criteria, taking into consideration sensitive bottom habitat, protected species, hydrographic conditions as well as social, cultural and economic conditions and compatibility with existing ocean uses;
  - promote species not dependent on high levels of fish meal and fish oil;
  - limit marine aquaculture to the use of indigenous species. (Exceptions could be made for the use of previously established species in existing operations that do not jeopardize native species or for species raised in land-based systems.)
- EPA should ensure that aquaculture facilities do not diminish water quality in public waters.
  - EPA should establish national effluent guidelines for marine aquaculture pursuant to requirements in the Clean Water Act.
  - All discharges from marine aquaculture facilities should be conducted pursuant to National Pollution Discharge Elimination System permits.
  - The guidelines should control the full range of pollutants including nutrient and chemical pollutants, as well as biological pollutants such as pathogens, parasites, and escaped fish.
  - EPA should develop water quality standards for federal waters, as required by the Clean Water Act.
- Regional ocean governance councils should set regional standards tailored to regional conditions and priorities, consistent with or more stringent than the national standards, and implemented by the appropriate federal or state authorities. These standards should
  - consider the cumulative as well as individual impacts of aquaculture facilities;
  - establish compliance verification and enforcement procedures;
  - hold aquaculture facilities accountable for adverse environmental impacts and non-compliance with the standards;
  - require all existing aquaculture facilities to achieve these standards within five years of their promulgation;
  - reward facilities for improved performance beyond the minimum standards;
  - preempt conflict with other users of marine resources affected by aquaculture operations.
- Efforts to coordinate state marine aquaculture programs, such as the Atlantic States Marine Fisheries Commission's development of voluntary guidelines, should be expanded.

Expand and improve marine aquaculture research with a focus on ecologically sustainable aquaculture practices.

- At the national level, the National Academy of Sciences should assess research needs necessary to achieve ecologically sustainable aquaculture and evaluate the quality of ongoing marine aquaculture research programs.
- At the regional level, funds should be made available to research institutions to work in conjunction with the regional ocean ecosystem councils, local, state, and federal agencies, and stakeholders for the coordination of marine aquaculture research efforts.
  - Research money should, at a minimum, be directed toward the development of closed aquaculture systems, marine polyculture systems, and feed substitutes to replace the use of fish meal and fish oil in aquaculture.
  - Research should inform the development of standards and management decisions regarding marine aquaculture at both the national and regional levels.

Restrict the expansion of marine finfish farming until standards for ecologically sustainable practices are implemented.

- The executive branch or Congress should place a moratorium on the expansion of marine finfish farms until standards for ecologically sustainable practices are set and implemented.
- The Secretary of Commerce (or the head of the national oceans agency) should determine whether marine finfish aquaculture, notably Atlantic salmon farming, meets these new national standards.
- If marine finfish farms do not meet the national standards, the moratorium should continue for nonconforming facilities until they comply with the standards.

Ensure an adequate regulatory review process to determine if the cultivation of genetically modified organisms is ecologically sustainable.

- The executive branch or Congress should place a moratorium on the domestic cultivation, marketing, and importation of live, genetically engineered marine or anadromous species until an adequate regulatory review process is in place that
  - consults the National Marine Fisheries Service and U.S. Fish and Wildlife Service on the environmental impacts;
  - provides the opportunity for public review and comment before approval;
  - exempts certain research under specific guidelines and procedures.

2. PROVIDE INTERNATIONAL LEADERSHIP FOR SUSTAINABLE MARINE AQUACULTURE PRACTICES.

The United States should negotiate and work with other nations to establish environmental provisions in international trade agreements to encourage ecologically sustainable marine aquaculture practices globally.

- The United States should exercise current authorities to bar trade in marine aquaculture products grown, extracted, or manufactured in a manner that is not ecologically sustainable, or is inconsistent with environmental requirements and practices in the importing nation.

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Bluestriped grunts, Florida Keys National Marine Sanctuary
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CHAPTER TWO
Governance for Sustainable Seas

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Dana Edmunds/Pacific Stock

Two-year-old Sage Nohara catches a small wave at Lanikai Beach, Oahu, Hawaii.

Regional Meetings
OF THE PEW OCEANS COMMISSION

Commission member Roger Rufe samples pineapple at the Maui Pineapple Plantation.
Deb Antonini/Pew Oceans Commission

Deb Antonini/Pew Oceans Commission

After boarding a tour boat docked at the Seward Small Boat Harbor (above) in August 2001, members of the Pew Oceans Commission (below) experienced Alaska's spectacular landscapes and marine life along the coast of Kenai Fjords National Park. Their visit to Alaska concluded with a short flight to Kodiak Island, where commissioners met with commercial fishermen and toured one of the island's salmon canneries.

Deb Antonini/Pew Oceans Commission

2000

July 6–7
Washington, D.C.

November 28–30
Monterey, California

2001

January 4
Portsmouth, New Hampshire

February 7–9
Maui, Hawaii

March 27–29
Charleston, South Carolina

April 17
Baltimore, Maryland

June 12–14
Rockport, Maine

July 18–19
Seattle, Washington

August 11–14
Anchorage, Alaska

August 15
Kodiak, Alaska

October 2–3
Portland, Oregon

November 28–30
New York City, New York

December 10
Des Moines, Iowa

Deb Antonini/Pew Oceans Commission

During the meeting in Monterey, California, commissioners visited Point Lobos State Reserve—known as the crown jewel of California's state park system.

2002

January 21–22
Monterey, California

March 14–16
Barataria/New Orleans, Louisiana

June 9
Ft. Lauderdale, Florida

June 13–15
Washington, D.C.

October 5
Providence, Rhode Island

Deb Antonini/Pew Oceans Commission

Lisa Levin, a professor at Scripps Institution of Oceanography, talks with commissioners Charles Kennel and Geoffrey Heal during a coastal development workshop held in Charleston, South Carolina. Dr. Levin participated in a panel discussion about the importance of and major threats to coastal habitat.

Justin Kenney/Pew Oceans Commission

Commissioner Leon Panetta joins students from Sunset Beach Elementary School during the airing of KidScience*—a popular science program on Hawaii Public Television.*

Deb Antonini/Pew Oceans Commission

Aboard Thrasher, *sternman George Harris (right) prepares fresh bait bags for his lobster traps. The trip aboard a Maine commercial lobster boat gave several commissioners an opportunity to experience firsthand the latest in lobstering techniques.*

Publications
OF THE PEW OCEANS COMMISSION

Ocean sunfish, off San Diego, California
Richard Herrmann

SCIENTIFIC REPORTS

Marine Pollution in the United States: Significant Accomplishments, Future Challenges
Donald F. Boesch, Richard H. Burroughs, Joel E. Baker, Robert P. Mason, Christopher L. Rowe, Ronald L. Siefert
(2001)

Marine Aquaculture in the United States: Environmental Impacts and Policy Options
Rebecca J. Goldburg
Matthew S. Elliott
Rosamond L. Naylor
(2001)

Introduced Species in U.S. Coastal Waters: Environmental Impacts and Management Priorities
James T. Carlton
(2001)

Coastal Sprawl: The Effects of Urban Design on Aquatic Ecosystems in the United States
Dana Beach
(2002)

Ecological Effects of Fishing in Marine Ecosystems of the United States
Paul K. Dayton, Simon Thrush, Felicia C. Coleman
(2002)

Managing Marine Fisheries in the United States: Proceedings of the Pew Oceans Commission Workshop on Marine Fishery Management
David L. Allison, George W. Boehlert, Daniel W. Bromley, Monica B. Goldberg, Susan Hanna, Burr Heneman, Timothy Hennessey, Richard Hildreth, Seth Macinko, Michael K. Orbach, Ellen K. Pikitch, Marc L. Miller, Timothy J. Ragen, Harry N. Scheiber
(2003)

Marine Reserves: A Tool for Ecosystem Management and Conservation
Stephen R. Palumbi
(2003)

WHITE PAPERS

A Dialogue on America's Fisheries: Summaries of the Pew Oceans Commission Focus Groups on Fishery Management
Staff of the Pew Oceans Commission
(2003)

Socioeconomic Perspectives on Marine Fisheries in the United States
Staff of the Pew Oceans Commission
(2003)

Acknowledgements

Surf grass carpets reef ledge. Cortez Banks, California

The Pew Oceans Commission wishes to express its gratitude to The Pew Charitable Trusts, whose vision and commitment to the well being of our living oceans brought us together and made this report possible. We appreciate as well the generous support from the David and Lucile Packard Foundation, the Rockefeller Brothers Fund, and the Oxford Foundation.

This report represents the combined wisdom of thousands of scientists, fishermen, teachers, environmentalists, businesspeople, boaters, divers, and a host of others who shared their perspectives and expertise with us at our regional meetings, public hearings, workshops, and in so many other ways. We thank all of you for sharing your stories. Some of your words struck us especially, and we salute the contributions of the individuals and organizations whose work is cited and whose words are quoted in our report. We extend our special gratitude to the distinguished experts and their peers who wrote and reviewed the seven scientific reports that informed our deliberations and recommendations.

Steve Simonsen/Marine Scenes

Coral polyps, U.S. Virgin Islands

Our analysis was broadened and our capacity to produce this report was assured by the dedication and talent of the Pew Oceans Commission staff. We extend much gratitude to our partners in this effort: the Commission's executive director, Christophe A. G. Tulou, and his colleagues Deb Antonini, Jennifer Black, Courtney Cornelius, Steve Ganey, Justin Kenney, Jessica Landman, Chris Mann, Jessica Riordan, Amy Schick, and Heidi Weiskel. And, in unison, we thank Bernice Wuethrich who gave us a singular voice through the magic of her editing. We also received invaluable administrative and moral support from the staff of Strategies for the Global Environment.

We commissioners are particularly grateful for the wealth of time and knowledge shared by staff within our own organizations who kept us informed, on time, in touch, and well-advised throughout the Commission's fact-finding and decision-making journeys.

As with all ventures of this magnitude and length, it is impossible to fully and appropriately convey our thanks for all the help we got along the way. This report is just the beginning of our work, and we hope to meet you again as we set a course for a better ocean future.

Index

With the flick of its flukes, a humpback whale dives in waters near southeastern Alaska.
Photo © www.brandoncole.com

Boldface references indicate illustrations; *italic* entries refer to picture legends (captions).

Pew Oceans Commission

CONNECTING PEOPLE AND SCIENCE TO SUSTAIN MARINE LIFE

Sea otters in Monterey, California, float among kelp beds.
Frans Lanting/Minden Pictures

PEW OCEANS COMMISSION

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Arlington, Virginia 22201
www.pewoceans.org

To me the sea is a continual miracle; The fishes that swim—the rocks—the motion of the waves—the ships, with men in them, What stranger miracles are there?

WALT WHITMAN
American Poet (Miracles, 1856)

Opposite Photo: Ron Dahlquist/rondahlquist.com

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Steve Simonsen/Marine Scenes

A stoplight parrotfish swims among soft and hard corals in Virgin Islands National Park, U.S. Virgin Islands. Parrotfish feed on the algae that grow on hard corals. They use special teeth in their throats to grind hard coral, which is deposited on the reef as white coral sand.